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The
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EDITORIAL

INTRODUCTION OF NEW CROPS

THE note on food crops grown at the Experiment Station, Peradeniya, which appears in this number is fuller in general information regarding the crop with which it deals than in useful data and conclusions on its adaptability for incorporation in a scheme of rotational cropping in those parts of Ceylon in which land is still available for that form of agriculture. It is not necessary to read between the lines to discover that the authors have not collected sufficient material to justify clear-cut advice to the practical farmer who wants to know whether he is likely to make a profit by growing sorghum, where he should grow it, and in what season. They hedge their statements with a barrier of reservation : sorghum is a good crop providing food for both man and beast, excellent in favourable conditions ; the conditions at Peradeniya produce excessive vegetative growth and small earheads ; the grain itself is liable to discoloration : these defects may be partly overcome by raising the crop in the dry zone ; places receiving more than 40 inches of rain a year are unsuitable for the crop—and we know that there is no part of Ceylon which receives less than 40 inches.

We suspect that this vagueness is induced not only by the natural caution of the scientist but also by the Department's experience with other crops. For example, adlay was recommended to the public on the experience of a couple of seasons in one or two places ; but the experience of two seasons of somewhat prolonged drought discouraged large-scale production. Again, the first trials with dhal were very promising, and the officers of the Department went all out to establish it as a peasant crop ; but with the weather experienced in the last two years during the cultivation season, the plant which in India attains a height of about three feet and produces an abundant crop of pods grew into a medium-sized tree and produced a wealth of wood and leaf but a comparatively small quantity of seed.

While the provisional data obtained from these pioneer trials for acclimatizing an exotic crop are useful and instructive and their publication should be encouraged, it is clear that the scope of the preliminary trials in all these cases was too narrow. The reason is not far to seek. The results of a limited number of trials carried out in one place are liable to be fortuitous, while results obtained in one district may not be true of another. Above all no useful purpose, useful in its immediate economic results and not in the acquisition of scientific knowledge, can be served by carrying out acclimatization trials in an environment which is different from that in which economic exploitation has to be attempted. To apply these general considerations to specific cases : if dhal and sorghum are to become normal farmers' crops, it must be in the dry zone, and no useful judgement with regard to their adaptability even in that zone can be pronounced until experiments have been carried out in different districts over a number of years with the crops planted at short intervals throughout the year ; for what does well in Hambantota district may fail totally in Tamankaduwa, and a plant which produces only wood and leaf in the normal agricultural season (October to February) may manifest its Indian qualities of usefulness if it is planted after the rainy season is over and is exposed to the stress of a dry spell punctuated by very light showers.

Why, then, does the Department not employ these methods of experimentation ? We believe that the answer is that the Department is trying to use for the promotion of seasonal farming an organization which was planned for dealing with perennial crops. Its central experimental farm is at Peradeniya, and its scientific research staff is stationed in the same town. No place in Ceylon could be less suitable as a centre for the present activities of the Department. The solution appears to be the migration of the Department to the dry zone, and the establishment of a large central agricultural station, comprising both irrigable and unirrigable lands, on which the senior scientific staff will live and carry out their experiments, assisted by a number of minor satellitic experimental stations located in different parts of the country. It follows as a necessary corollary that these minor stations must be manned not by men of the average agricultural instructor type but by officers with the education and temperament necessary for undertaking scientific experiments. This means a considerable increase of staff, and increased expenditure. The alternative is stagnation accompanied by a feeling of discontent with the Department for its failure to do what it cannot do with its present equipment.

A STUDY OF THE FACTORS INFLUENCING THE GRADING OF GRAPE, PAPAYA AND GRAPEFRUIT

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INTRODUCTION

THE importance of preparing fruits properly for the market, and the necessity and advantages of grading them before packing are not generally realized by Indian fruit growers. The necessity of grading fruits has been emphasized by horticultural workers of this country. Prompted by the recommendations of the Mango Marketing Committee, Bombay (1925), Cheema and Dani (1931) carried out certain trials regarding the grading and marketing of mangoes in Bombay. The Committee on the Improvement in the Marketing of Fruits and Vegetables in the Town of Bombay (1934) lent further support to the absolute necessity of grading not only mangoes but all kinds of fruits and vegetables before they are marketed. This Committee observed that it was essential to work out proper standards for grading each of the Indian fruits and vegetables somewhat on the lines adopted by the National Marks Scheme of England, and stated that research should be carried out on the fixing of grades. Naik (1935) and Nair (1932) have also advocated the need for grading fruits

when marketing them. An Agricultural Grading and Marketing Act was enacted in 1938 and several experimental fruit grading stations are now set working under this Act.

The work presented in these pages is an effort made towards finding out natural grades on a scientific basis in the case of three fruits grown in India, after a thorough study of a large number of them. It is hoped that it will be of some value in improving the present system of marketing the fruits on which these observations are recorded, and in working out grade standards for other fruits.

GRADING STANDARDS

Many packers of fruits in India sort out fruits of different qualities more or less roughly into different lots before they are despatched to the market. Selecting the very best fruits from the lots and " topping " with them baskets containing inferior quality at the bottom is very common in this country. This practice is evidently unhappy, and its result in the market is definitely adverse to the packer in realizing reasonable price for his produce. It often happens that buyers empty " topped " baskets, and offer prices for the whole lot on the basis of the bottom-most quality. It is, therefore, essential in the interest of both growers and packers as well as consumers that proper grading and packing of different grades of fruits in separate containers according to definite standards, and using distinctive labels for each quality, should come into general practice in this country as soon as possible; the earlier it is done the better it would be for the fruit industry.

Clearly enough, fruits have to be graded according to their value depending upon their quality in any scientific system of grading them. *Quality* as applied to fruits is a highly comprehensive term. It is made up of several factors such as appearance, size, shape, and maturity of fruits ; quantity, consistency, colour, taste, and flavour of pulp ; size, shape, hardness, and the number of seeds, &c. These factors are much influenced by cultural and environmental conditions. Such a complex factor as quality and its standards are, therefore, bound to vary widely in different fruits, although varietal characters are more or less stable in most cases. Unfortunately, the internal characters relating to the pulp and seed, which are very important in determining the quality of fruits especially on the basis of their utility, cannot be put to test in determining their grades. For example, it is impracticable to open and scrutinize the inside of the fruits meant for packing, except perhaps in the case of one or two samples from each lot. For practical commercial purposes, therefore, a certain amount of

dependence has to be placed on the variety for its internal characters, and this fact naturally adds prominence to the external ones. Of the latter the following may be considered as the most important :

(*a*) Appearance ; (*b*) Size ; (*c*) Shape ; and (*d*) Maturity.

(*a*) The *Appearance* of fruits is a multiple character, chiefly depending upon colour, wartiness or smoothness of skin, cleanliness, and blemishes due to mechanical injury, attack by insects and fungi or other organisms. It is most influenced by colour, and the fruits which have developed the full and characteristic hue or hues of the variety naturally command a higher premium in price. Blemishes due to diseases and insect infestation or injury to the skin or sunscald, impair colour as well as the general appearance, and irrespective of the size of the fruits or the quality of the pulp inside, they reduce the market price of the fruits considerably. For example, Bhokari grapes are discounted in their quality and price if they bear marks of the attack of mildew, or if they do not show up their characteristic bluish-rosy tinge. Grapefruits with warty and fluffy skin are not appreciated. Mosambi oranges attacked by a trouble called " Tambera " in the Deccan, which appears in water-logged and over-irrigated orchards, get defaced and fetch a low price, although the affectation is superficial and skin-deep, and does not interfere much with the internal quality of the fruits. Similarly markings due to *anthracnose* on papaya, and to canker on limes, reduce their market value very much.

(*b*) The *size* of a fruit, defined by its dimensions and often closely related to its weight, can be marked out without much difficulty. In order to fix grades of different sizes of fruits of any variety, it is necessary to measure accurately and weigh a large number of them, so as to derive a general range of the approximate grades, which may naturally suit that particular variety. This done, fruits may be separated out roughly by sight into lots of different grades. This can be easily put to a further test by having ply-wood or card-board pieces with holes suitable to each grade through which fruits of the higher grades should not pass. This method is found to be a dependable and practical one in grading apples, and Santra and Mosambi oranges. On the basis of the study recorded in this paper, the authors recommend this method for grapefruits also, in a slightly modified form. It is found that the size factors, length, circumference and weight of fruits, are positively correlated in the case of papaya, and for reasons explained under this fruit, grading by weight is recommended for it.

(*c*) *Shape* is more or less naturally fixed for most of our fruits and unless there is a departure from the normal due to

malformation or otherwise—and this rarely happens—this character may not play an important role in deciding the standard for grading. True, the different strains of the same variety may considerably differ in the shape of their fruits, as for example in the case of Alphonso mangoes from Navsari, which differ from the Ratnagiri fruits in being more rounded with a broader base. Similar is the case with the Santra orange which has two strains, one with a short neck at the stalk end and the other without it. In such cases, it is easy to distinguish the strains, and to grade fruits of the same strains separately according to the other characters. The shape of the branches and berries of Bhokari grapes as well as that of grapefruits is fairly uniform, while that of papaya varies very considerably. This fact is taken into consideration while suggesting grading standards for these fruits.

(*d*) The *maturity* of fruits is a factor which should count in grading fruits like mango and papaya, which are picked before they are fully ripe on the tree, more than in oranges and grapes, which are usually harvested on ripening. If, when picked, the fruit is not fully developed and sufficiently matured, its quality becomes poor after ripening. Cheema and Dani [1932, 1933] have defined three stages of maturity namely, A, B, and C, in the case of the Alphonso mango for purposes of export, and their experience, later on supported by cold storage experiments at Poona, is that these stages of maturity affect both the storage life of the fruits as well as their flavour and taste. Similarly, a papaya fruit, however large in size, is poor in flavour unless it was picked when the colour of the skin turned slightly yellowish. The maturity of citrus fruits and grapes is judged by the colour of the skin which they attain while picking. It is a general practice in this country to ripen banana artificially, especially for certain festivals when large quantities of this fruit are in demand. Green and immature bunches are harvested and forced to ripen by stacking them under a special hastening process. Though the skin of fruits attains a fair colour by this method, the taste of the fruits inside is anything but commendable. In this fruit, therefore, special attention is needed in specifying grades in order to prevent the inclusion of artificially-ripened immature fruits. In short, it is necessary to work out the right stage of maturity for picking each kind and variety of our fruits, both for internal as well as export trade.

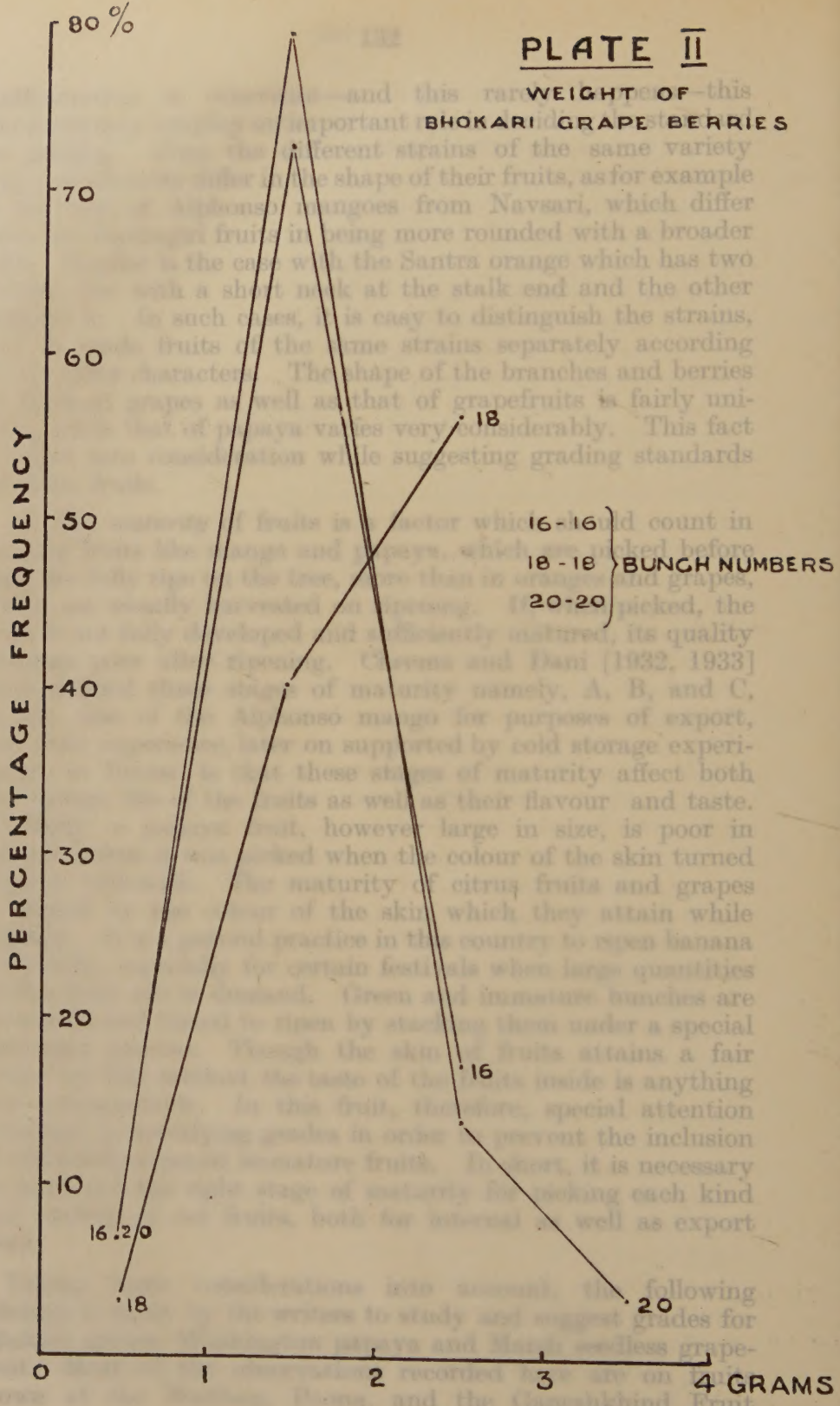
Taking these considerations into account, the following attempt is made by the writers to study and suggest grades for Bkokari grapes, Washington papaya and Marsh seedless grapefruit. Most of the observations recorded here are on fruits grown at the Modibag, Poona, and the Ganeshkhind Fruit

PLATE II

WEIGHT OF
BHOKARI GRAPE BERRIES

PLATE II

WEIGHT OF BHOKARI GRAPE BERRIES



S.G.O. 2.4.41.

PLATE I

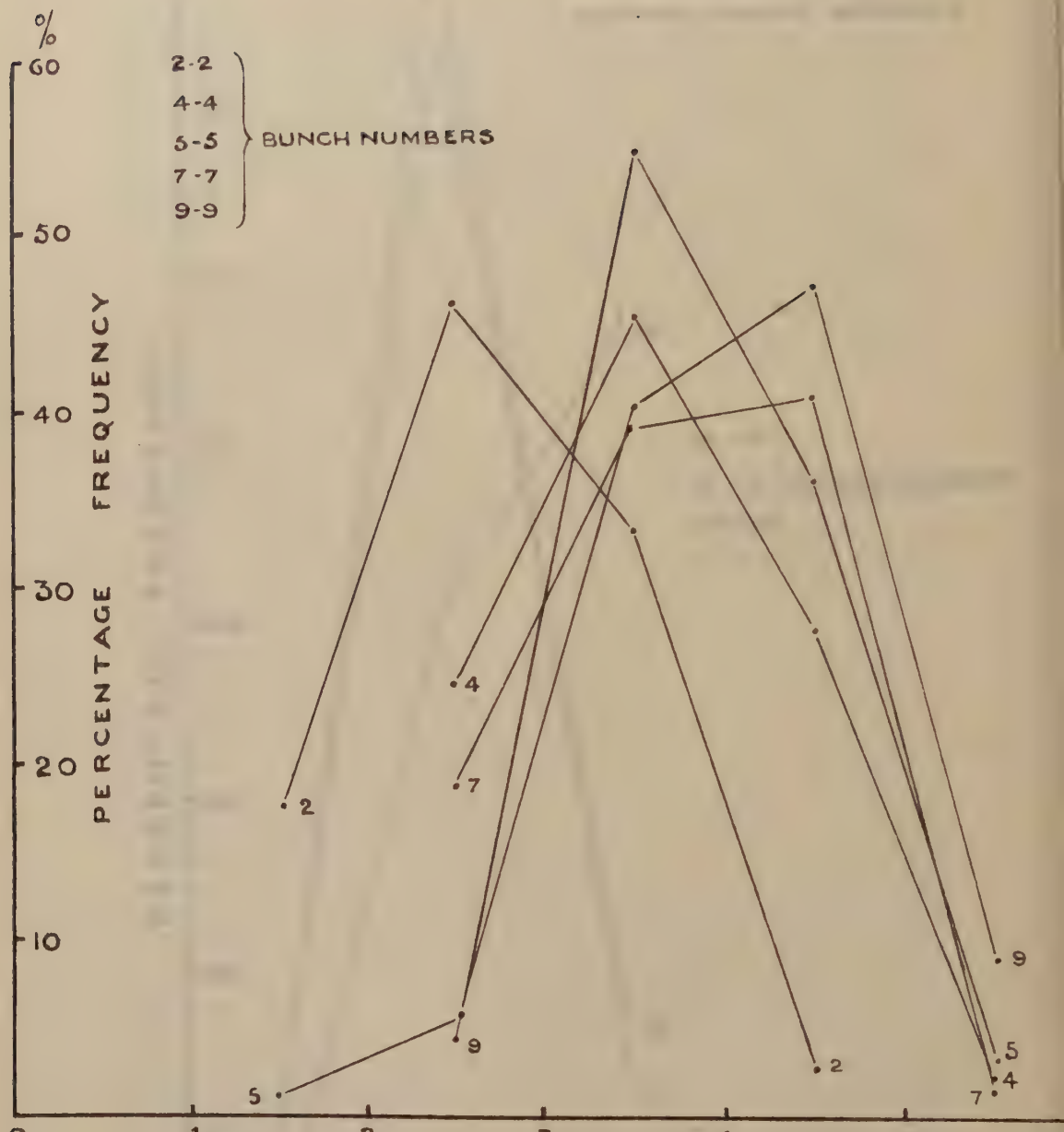


PLATE I

WEIGHT OF BHOKARI GRAPE BERRIES

S. G. O. 2.4.41.

Experiment Station, Kirkee, during the years 1935–37, while some of the observations have been later on added by work at Baroda.

GRAPE

In a Bhokari grape plantation of about two acres at the Ganeshkhind Fruit Experiment Station, Kirkee, the crop of the 1935–36 season was very good and absolutely free from mildew and other diseases. There was no cold wave in that year, and the crop was therefore free from frost. Observations recorded in Table II. are on bunches of this crop, while those presented in Table I. are from bunches of the 1938–39 crop.

The Bhokari is the most common commercial variety of grapes extensively grown in Western India. It is the highest yielder of all the locally-grown varieties. Its bunches are characteristically tapering, compact and large, with a " thumb " or bunchlet shooting out from near the base. The berries are fairly large, round but slightly tapering towards the stem end, and develop a faint rosy bloom when ripe. The colour of the berries is green. Their skin is thick, pulp watery, and the taste and flavour, when the berries are fully ripe, are an agreeable blend of acid with sweet.

In grading grapes apparently two main considerations have to be confronted, namely, the bunch and the berry. The size of individual berries varies but within limits, while that of bunches varies widely in any given variety. There appears to be, however, a tendency for the berries to be larger in smaller bunches than in larger ones. The shape of bunches in the Bhokari variety is more uniform than in other varieties like Fakadi and Kali Sahebi. Cultural and climatic conditions also influence the size of berries, but when they do so, the bunches are also affected. In Table I., it may be seen that the bunches of the first lot (1 to 13 from top) are distinct from those of the second lot, both in the general weight of the bunches as well as in that of individual berries. It would thus appear that, in a given vineyard, the quality of the bunches and berries in them are fairly uniform, and generally the bunch counts more than the berry in determining the quality for marketing purposes. Ripeness being assured, therefore, the chief guiding factors for grading would be the size, compactness, and weight of the bunch in the case of grapes. Further observations on other varieties support this view (Pl. IV and Pl. V, fig. 1). Compactness is fairly uniform in all healthy bunches, and the size of the bunches varies proportionately with their weight. It was, therefore, decided as a practical measure for field work to take the weight of bunches only for grading purposes. Table II. represents the data collected on the weight of grape bunches.

TABLE I.

Statement showing the weight of bunches and individual berries of the Bhokari variety of grapes.

Bunch No.	Weight of bunch in gms.	Total No. of berries.	Range of Weight of berries in gms.			Frequencies according to weight of berries.											
						0 to 1 gm.		1 to 2 gms.		2 to 3 gms.		3 to 4 gms.		4 to 5 gms.		5 to 6 gms.	
			Min.	Max.	Ave.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	425·25	128	2·10	4·80	3·32	—	—	—	—	39	30·46	75	58·59	14	10·93	—	—
2	402·57	145	1·12	4·40	2·77	—	—	26	17·58	67	46·20	48	33·10	4	2·75	—	—
3	391·23	110	1·95	5·47	3·55	—	—	1	0·91	25	22·72	65	59·09	17	15·45	2	1·81
4	388·40	106	2·25	5·20	3·66	—	—	—	—	26	24·52	48	45·28	29	27·35	3	2·83
5	351·54	92	1·40	5·21	3·82	—	—	1	1·08	5	5·43	50	54·34	33	35·86	3	3·29
6	331·70	82	2·00	4·70	4·04	—	—	1	1·21	25	30·48	46	56·09	10	12·19	—	—
7	306·18	69	2·14	5·10	4·43	—	—	—	—	13	18·83	27	39·13	28	40·58	1	1·44
8	303·35	96	1·22	4·91	3·16	—	—	7	7·28	34	35·41	47	48·95	8	8·33	—	—
9	208·32	45	2·90	5·57	4·63	—	—	—	—	2	4·44	18	40·00	21	46·66	4	8·88
10	191·31	52	2·07	4·85	3·68	—	—	—	—	12	23·07	28	53·84	12	23·07	—	—
11	178·61	66	1·47	4·25	2·70	—	—	3	4·54	47	71·21	14	21·21	2	3·03	—	—
12	174·30	49	1·00	5·30	3·55	—	—	3	6·12	3	6·12	34	69·38	8	16·32	1	2·04
13	150·26	49	1·85	4·55	3·06	—	—	2	4·08	21	42·85	20	40·81	6	12·24	—	—
14	107·73	48	0·39	3·75	2·24	3	4·25	16	33·33	26	54·16	3	6·25	—	—	—	—
15	99·23	40	1·30	3·70	2·48	—	—	10	25·00	25	62·50	5	12·50	—	—	—	—
16	96·39	58	0·34	2·91	1·66	4	6·89	46	79·31	8	13·79	—	—	—	—	—	—
17	70·88	34	0·82	3·04	2·08	1	2·94	17	50·00	15	44·11	1	2·94	—	—	—	—
18	68·04	32	1·00	3·00	2·12	1	3·12	13	40·62	18	56·25	—	—	—	—	—	—
19	59·54	36	0·72	2·57	1·65	2	5·55	24	66·66	10	27·77	—	—	—	—	—	—
20	47·20	29	0·71	3·28	1·62	2	6·89	21	72·41	5	17·24	1	3·44	—	—	—	—
21	36·86	19	1·60	2·74	1·94	—	—	8	42·10	11	57·90	—	—	—	—	—	—

Note.—Bunches 1 to 13 were obtained from the Ganeshkind Fruit Experiment Station, Kirkee, Poona, while the remaining were grown on the Model Farm, Baroda (1938-39).

The weight of berries of bunches from Poona is generally higher than that of berries from the Baroda lot, the averages being 3·57 gms. and 1·97 gms. respectively. The average weights of berries, the weight of bunches and the number of berries in each bunch show that the individual berries do not vary in size and weight in proportion to the size and weight of the bunches, but remain more or less uniform, within a limited range. The frequencies of weight of berries are reduced to graphs in the case of bunch Nos. 2, 4, 5, 7, and 9 (Pl. I), and bunch Nos. 16, 18, and 20 (Pl. II).

Block by Survey Dept.

FIG. 1.—FAKDI GRAPE (GREEN).

Block by Survey Dept.

FIG. 2.—A LARGE LONG PAPAYA FRUIT.

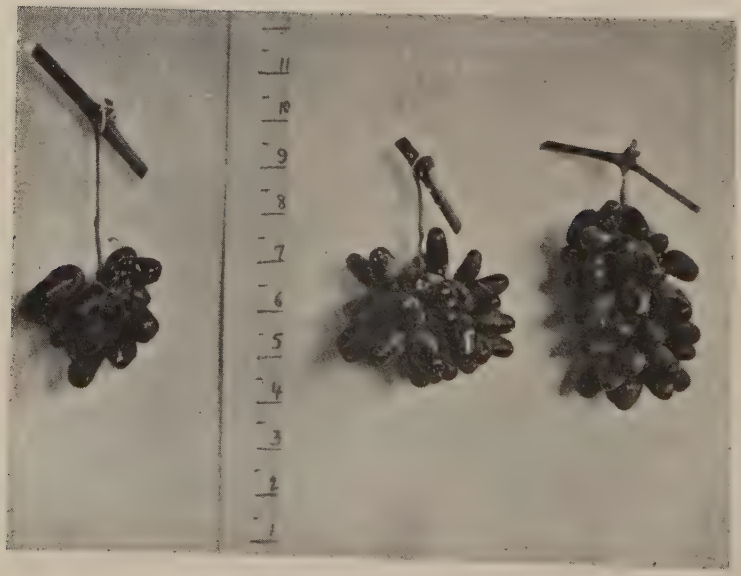
Length of fruit 18 in.; circumference 18 in.; weight 11 lb.; seeds 111.

PLATE IV.

GRAPE BUNCHES OF DIFFERENT VARIETIES AND SIZES. THE SIZE OF BERRIES IS UNIFORM IRRESPECTIVE OF THE SIZE OF BUNCHES IN ALL THE VARIETIES.

Block by Survey Dept.

FIG. 1.—BHOKARI (GREEN).



Block by Survey Dept.

FIG. 2.—KALI SAHEBI (BLACK).

TABLE II.

Frequency of Bhokari grape bunches according to weight.

Weight in ounces ..	0–4	4–8	8–12	12–16	16–20	20–24	Above 24	Total
Number of bunches ..	210	390	388	113	37	9	3	1150
Percentage :	18·3	33·9	33·7	9·8	3·2	0·8	0·3	100

It is seen from this table that nearly 96 per cent. of the bunches weighed less than one pound (16 ozs.), and hardly four per cent. more than that. Bunches that weigh more than twenty ounces and those weighing less than two ounces are extremely rare. These figures appear to suggest natural grades of Bhokari grapes as :

(1) *Special grade* with bunches weighing 12 ounces and above.

(2) *First grade* with bunches weighing 4–12 ounces.

(3) *Second grade* with bunches weighing below 4 ounces. There should be no objection to including bunches of the higher grades in packages of the lower ones, when difficulty arises in finding a sufficient number of bunches of the higher grade alone for making up a whole package. In such cases it is desirable to mention on the package label the quantity of the higher grade bunches included in it so as to gain a premium on the price obtained for the package as far as possible.

Grape bunches are often blemished due to the attack of mildews and other diseases, spraying and dusting marks, mechanical injury, &c. While blemishes on about five per cent. of the berries in the bunch may be allowed as normal, their occurrence to a greater extent is sure to reduce the value of the bunch. In grading fruits for the market, it is essential that blemishes or other defects should be within the limit at which fruits are safely edible as tested by an expert. Under this proviso, the grade value of grape bunches may be discounted due to their blemishes on the basis of the following formula :

$$\text{Total percentage of blemishes} - 5 \text{ (or allowable percentage)} \over 2$$

Under conditions of normal cultivation, treatment of diseases and care in handling, the percentage of blemishes on grapes is usually low. This formula, therefore, provides sufficiently

against the blemishes in grapes (and on any fruit for a matter of that), in adjusting the market value of the bunches packed. For example, no reduction in value will be made when the blemished berries do not exceed five per cent., and when they amount to, say, thirty per cent. of the berries, the grade value of the bunches will be discounted by 12·5 (equal to $\frac{30-5}{2}$) per cent. Of course, it is necessary to state on the package label the actual percentage of blemished berries in the contents of the package for applying this formula at the market end.

PAPAYA

Fruits for these observations were taken from a plantation of over 500 trees of the Washington papaya variety at the Modibag garden, Poona. The Washington papaya has purple or pinkish stem and deep yellow flowers. Fruits are usually of ovate shape, sweet taste, agreeable flavour and fair keeping quality. The variety is a prolific bearer. It has rapidly gained popularity in Western India, its acreage being at present 1,091 acres in the Bombay Presidency. Fruits are harvested when they just turn yellow for the local market, and a little earlier for longer journeys. Papaya is a quickly perishable fruit, and its movements to distant markets under the present transport conditions is very much limited.

Due to propagation of plants from seeds and the dioiceous nature of the trees, a good deal of variation occurs in the shape, dimensions and the general quality of papaya fruits. Fruits of much larger size than those that are studied here are not infrequently seen in the market (Plate V, fig. 2). Their number, however, is limited. Although large fruits of papaya may occasionally bring in a fancy price, the difficulty in selling them under ordinary circumstances is great, as no average family can buy or consume such a bulky fruit. Large fruits are often associated with loss and wastage. The fruits studied here are of the average mass lot and highly representative of the normal market demand.

A number of small fruits are also produced in plantations especially about the end of the economic life of trees. They are generally unmarketable in bulk and are readily sold cheaply in villages and on way-side stalls.

In the case of this fruit three characters, namely, weight, length and maximum circumference have been studied. Length represented the distance from the stalk to the flower end of the fruit, measured over the outward curvature. A total number of 786 fruits were studied.

The following tables of frequencies are given :—

TABLE III.

Frequency of papaya fruits by weight in ounces.

	Below 30 ozs.	30–35 ozs.	35–40 ozs.	40–45 ozs.	45–50 ozs.	50–55 ozs.	55–60 ozs.	60–65 ozs.	65–70 ozs.	70–75 ozs.	75–80 ozs.	80–85 ozs.	85–90 ozs.	90–95 ozs.	95–100 ozs.	Total
Numbers 76	54	72	62	118	66	97	77	40	42	39	10	21	5	7	786	
Percentages 9·7	6·8	9·2	7·9	15·0	8·4	12·3	9·8	5·1	5·3	5·0	1·3	2·7	0·6	0·9	100	

TABLE IV.

Frequency of papaya fruits by length in inches.

Below 6 in.	6–7 in.	7–8 in.	8–9 in.	9–10 in.	10–11 in.	11–12 in.	12–13 in.	13–14 in.	Total.
Numbers 12	43	121	231	237	104	33	4	1	786
Percentages 1·5	5·5	15·5	29·4	30·1	13·2	4·2	0·5	0·1	100

TABLE V.

Frequency of papaya fruits by circumference in inches.

Below 15 in.	15–16 in.	16–17 in.	17–18 in.	18–19 in.	19–20 in.	20–21 in.	21–22 in.	22–23 in.	23–24 in.	Total
Numbers 158	108	134	142	106	72	47	13	4	2	786
Percentages 20·1	13·8	17·1	18·1	13·4	9·2	5·9	1·6	0·5	0·3	100

On working out the correlation of these characters, it was found that the correlation was positively significant between any two of them. The following correlation coefficients are noticed :—

Length × Circumference (786 individuals), 0·52.
Circumference × Weight (do.), 0·80.
Length × Weight (do.), 0·70.

These figures lead us to the fact that, as all the three characters are positively correlated, any one of them might serve as well in fixing the grades of papaya fruits for marketing purposes. Simplicity in handling and conformity to market conventions are in favour of taking weight as the guiding factor in preference to length or circumference. On the basis of weight, therefore, the following grades are proposed as natural for papayas :—

Special grade with fruits weighing 80 ozs. and above.
First grade with fruits weighing 60 to 80 ozs.
Commercial grade I., do. 40 to 60 ozs.
Commercial grade II., do. 20 to 40 ozs.

In assigning these grades to any lot of fruits, due weight should be given to the appearance and maturity of the fruits. Papaya fruits are likely to be discountenanced when blemishes due to *anthracnose*, sunscald, and the like appear on them. The grade value of fruits may be lowered by applying the formula discussed under grapes, when they display blemishes. At the time of selling, if the fruit is too soft or over-ripe, it fetches a lower price than it would have, if it were just soft to ensure proper ripeness, but sufficiently hard to stand peeling and cutting, which is the stage best suited for the table, and on which basis the fruit should have been evaluated in relation to ripeness and consistency.

GRAPEFRUIT

The third fruit studied is the grapefruit of the Marsh seedless variety. Fruits were taken for observation from the fairly large (about four acres) plantations of the Modibag and Ganeshkhind Fruit Experiment Station, Kirkee. In grapefruits as in other citrus fruits, the coarseness of rind, lack of juice and fluffy pulp inside reduce their market value considerably. Smooth and thin-skinned fruits of quality can be made out easily. It is suggested that such fruits alone be preferred for marketing under standard grades.

The Marsh seedless grapefruit is of medium size, pyriform oblate or roundish in shape, smooth-skinned and attains a whitish yellow colour when fully ripe. The pulp is juicy and its colour is greyish-green. The juice is abundant and agreeably bitter and acidic. The cells are of medium size and not coarse. Not much of rag is present. Pips are sometimes found developed. The tree thrives under Deccan and Gujerat conditions and bears heavily. Fruits are borne singly or in bunches of even ten or more. Its present cultivation is very limited, but it is on the increase.

Length, maximum circumference and weight are the characters studied in the case of grapefruits also. A total number of 990 fruits were studied. The following tables of frequency are given :—

TABLE VI.

Frequency of grapefruits by weight in ounces.

Below 8 ozs.	8–12 ozs.	12–16 ozs.	16–20 ozs.	20–24 ozs.	24–28 ozs.	28–32 ozs.	Total
Numbers 4	97	336	367	141	40	5	990
Percentages 0·4	9·8	33·9	37·1	14·3	4·0	0·5	100

TABLE VII.

Frequency of grapefruits by length in inches

2–3 in.	3–4 in.	4–5 in.	5–6 in.	Total
Numbers 11	382	526	71	990
Percentages 1·1	38·6	53·1	7·2	100

TABLE VIII.

Frequency of grapefruits by circumference in inches.

9–10 in.	10–11 in.	11–12 in.	12–13 in.	13–14 in.	14–15 in.	15–16 in.	16–17 in.	17–18 in.	Total
Numbers 11	21	242	303	253	109	40	8	3	990
Percentages 1·1	2·1	24·5	30·6	25·6	11·0	4·0	0·8	0·3	100

In the case of grapefruit, too, there is positively significant correlation between any two of the three characters studied. The coefficients of correlation are given below :—

Weight × Length (990 individuals), 0·63.
Weight × Circumference (do.), 0·81.
Length × Circumference (do.), 0·83.

Grapefruit is usually sold by the number and not by weight. The shape of the fruits does not vary much. The size of the fruit is, therefore, the factor that controls its price. Owing to the peculiar shape of grapefruits, their size depends upon circumference even more than on length. In grading them it may be found easy and convenient to pass these fruits through circular holes of various diameters. Grapefruits of unduly large size are not appreciated for table use. Large fruits tend to be thick-skinned and fluffy. Fruits of medium size command popularity. Thus taking circumference as the guiding factor, the following grades may be acceptable for grapefruits :—

* *First grade*, fruits with circumference of 12–14 in.
Second grade, fruits with circumference of 14–16 in.
Third grade, fruits with circumference of 10–12 in.

**Note.*—An explanation seems to be called for in these grade specifications. Fruits of medium size, as explained in the body of the discussion, are most popular being both handy and convenient for table consumption. They are therefore placed in the highest grade. The larger fruits are placed in the second grade as they generally contain more juice and are more economic, although their size and appearance may not be in their favour, than the smaller lot which are given the third place. Grading inversely according to the size of fruits would place the smallest fruits in the highest grade, which is evidently impracticable.

In actual field work it is extremely laborious to measure the circumference of each and every fruit for the sake of grading. It is, therefore, suggested that ply-wood pieces, having holes of different sizes may be used for this purpose. Holes having diameters of 3, 5, 4·0, 4·5, and 5·0 in. approximately agree with the circumference records of fruits noted above and are both easily understandable and convenient to handle by the mass of average fruit growers, and hence they may be adopted to grade fruits according to the above standards (Pl. III) :—

First grade, fruits which pass through 4·5 in. hole and not 4·0 in. hole.

Second grade, fruits which pass through 5·0 in. hole and not 4·5 in. hole.

Third grade, fruits which pass through 4·0 in. hole and not 3·5 in. hole.

The above grades are meant for healthy and sound fruits. Diseased and sunscalded fruits are no good for marketing under standardized grades. Blemished fruits, if not objectionable for human consumption, may be graded according to the above size standards and then discounted in value according to the formula given under grapes. Fruits that do not fall under these grades may be utilized for bottling their juice or for wayside selling as fresh fruits of ungraded quality.

SUMMARY

Proper grading of fruits is an essential requirement of profitable marketing. Grade standards would naturally be based on the quality of fruits. They should be as natural as possible and meet the economic requirements of growers and consumers and help the disposal of fruits in a manner satisfactory to both of them. The various factors that control the quality of fruits are discussed, and on their basis a large number of Bhokari grape bunches, Washington papayas, and Marsh Seedless grapefruits are studied. Suitable grade standards are then recommended for these fruits. The factors studied in detail are the weight of bunches and individual berries in bunches of the Bhokari grape, and the length, circumference and weight of Washington papayas and grapefruits of the Marsh Seedless variety. It is observed that the size factors in papayas and grapefruits are correlated. A new formula is suggested to adjust the grade value of fruits suffering from blemishes.

ACKNOWLEDGEMENTS

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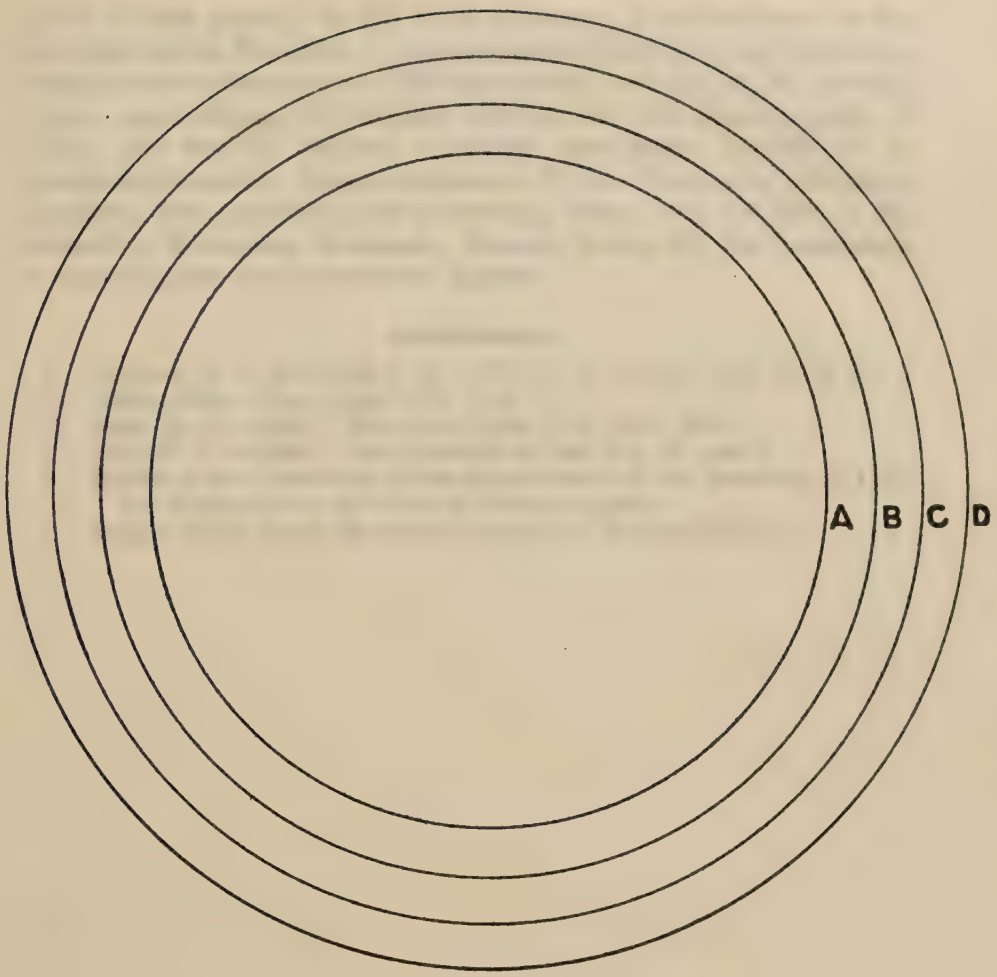

PLATE III

Size of holes for grading grapefruits :

A	..	3·5 inches	diameter
B	..	4·0 do.	do.
C	..	4·5 do.	do.
D	..	5·0 do.	do.

First grade fruits pass through C and not through B.
Second grade fruits pass through D and not through C.
Third grade fruits pass through B and not through A.

S. G. O. 2.4.41.

A
B
C
D

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A LEAF SPOT DISEASE OF ANNUAL PHLOX

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A DISEASE causing considerable damage to plants of *Phlox Drummondii* was observed in the writer's garden* in February, 1941. It was associated with a fungus identified as a species of *Septoria* new to Ceylon, and appeared to merit a short description.

In the early stages of the disease, spots are formed on the lower leaves which are prematurely shrivelled or defoliated. Under suitable conditions, the disease later spreads until most of the leaves are affected. The plants are rendered extremely unsightly and make little growth, the new leaves being stunted and curled and the period of flowering reduced. The spots (Pl. I, fig. 1) originate either at the margin or in the centre of the leaves. They are at first rounded or irregular in shape, about 2–3 mm. in diameter, and of a dull brown or olivaceous colour. As they increase in size, their colour changes to pale brown or whitish, and their outline becomes more uniformly circular, except where two or more spots coalesce. Commonly, they remain as distinct spots up to 2 cm. in diameter. The centre of the spot may appear raised and of a different colour, usually paler, and this is believed to indicate the former extent of the infection arrested temporarily by a period of dry weather or other unfavourable conditions, from which a more rapid spread has later occurred. Around the spots, yellow areas are formed which soon become wedge-shaped, the discolouration running back to the mid-rib following the direction of the lateral veins. These wedge-shaped areas later become brown and completely dried out, after which the whole leaf usually shrivels or drops off.

Extra detail can be observed in leaves kept in a moist chamber, or during a spell of damp weather. Under these conditions, the spots spread more rapidly and develop a narrow purplish margin, outside which for about another 2 mm. the normal green colour of the leaf persists, in strong contrast with the surrounding yellowed area. Similar "green rings" which appear to be due to a local stimulation of the cells by the products of fungal metabolism have been described by Forward (6)

* St. Coombs, Talawakele. Elevation 4,500 feet.

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FIG. 1.—LEAVES OF *Phlox Drummondii* WITH LEAF SPOT DISEASE ASSOCIATED WITH *Septoria Drummondii* ELL. & EV. (NATURAL SIZE).

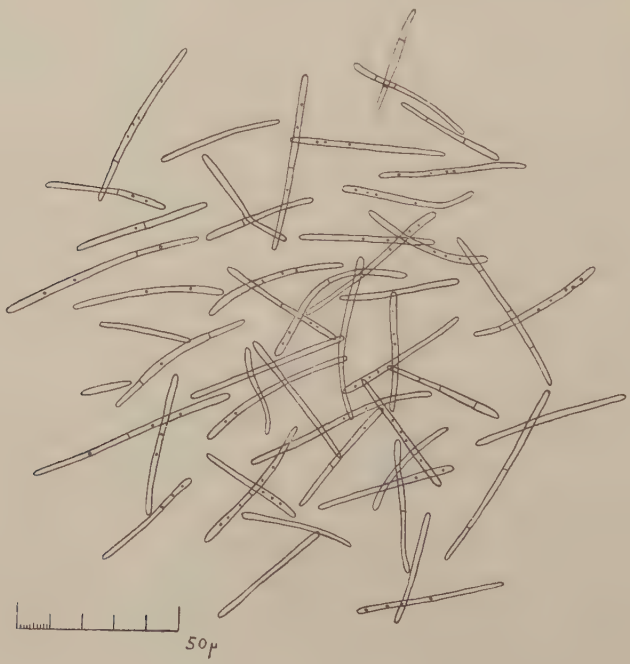

FIG. 2.—FRESH SPORES IN WATER (CAMERA LUCIDA DRAWING × 430).

in the case of rust pustules developing on etiolated wheat leaves. A greenish or olivaceous tinge may persist on the underside of the spot, after the surrounding tissue has become brown and dried out.

Pycnidia are developed simultaneously with the spots and under damp conditions may even appear locally in small numbers before any definite spotting is discernible. They occur chiefly on the upper surface of the leaf, and in the larger spots show a slight tendency to zonation. This is less marked and the pycnidia are also probably less numerous than is commonly observed in related species of fungi. To the naked eye the pycnidia appear as dull brown, dusty granules. Emergence of spore tendrils could be seen after a few hours in a moist chamber. Examined *in situ* using a 1 in. objective and transmitted light, the pycnidia appear pale brown in colour and the relatively large ostiole is clearly visible. The epidermis is ruptured only on the emergence of the spores, *i.e.*, the pycnidia are completely immersed, not erumpent. The measurement of 50 pycnidia gave the following results :—

Diameter of pycnidia	55 – 160 μ	..	Mean	103·4 μ ± 4·02 μ*
Diameter of ostiole	15 – 45 μ	..	Mean	30·1 μ ± 0·95 μ

The spores (Pl. I, fig. 2) which with the pycnidia, are typical for the genus *Septoria* are hyaline, filiform or slightly wider at one end (*i.e.* acicular), straight or slightly curved or bent, and have up to three septa with a varying number of minute guttules. Their size varies within wide limits, as shown by the following measurements of 50 freshly exuded spores in water :—

Length	17·0 – 66·5 μ	..	Mean	43·3 μ ± 1·32 μ
Breadth	1·5 – 3·0 μ	..	Mean	2·1 μ ± 0·05 μ

Three species of *Septoria* have been reported in the literature as associated with leaf spot diseases of various *Phlox* spp. These are, in order of publication—

(1) *S. Phlogis* Sacc. & Speg.
(2) *S. divaricatae* Ell. & Ev. (= *S. Phlogis* Ell. & Ev. *non* Sacc. & Speg.)
(3) *S. Drummondii* Ell. & Ev.

In attempting to identify the Ceylon fungus, it will be necessary to give a short account of these three species and of their claims to be regarded as distinct from one another. Briefly, *S. Phlogis* was originally described from Europe, the hosts, according to Saccardo (11) and Grove (7), being *Phlox decussata, paniculata,* and other perennial forms. *S. divaricatae* was the name given to an American fungus which Ellis and Everhart (3) at first (1887) believed to be identical with the

* The standard error of the mean is implied by this expression.

European species but later (1889) described as distinct on account of its smaller and less evidently septate spores. The same authors (4) in 1894 distinguished the fungus on the annual *Phlox Drummondii* as a third species having spores larger than those of *S. divaricatae* but nevertheless still smaller than those of the European *S. Phlogis*. Other slight differences are involved, as may be seen from the following table in which the essential characters of the three published species (taken from the sources quoted above) are tabulated together with those of the Ceylon form.

TABLE I.

Distinguishing Characters of Septoria Spp. on Phlox

	Spots on Foliage.	Pycnidia.	Spores.
S. Phlogis	Clear brown at first, then whitish. Often confluent. Size variable, shape round or angular.	Epiphyllous, covered, clear brown. Ostiole wide. Size 100 – 200μ.	Filiform, mostly bent or flexuose. 1-3 septate, in size 40 – 60 μ x 1 –2 μ.
S. divaricatae	Olivaceous below, whitish above. 1-3 mm. diam. or larger and confluent, with purplish border. Shape round.	Epiphyllous, rather numerous, immersed, then bursting epidermis, dull black. Size 100 – 120 μ.	Filiform, nearly straight, aseptate. 18 – 30 μ x 0·75 – 1 μ.
S. Drummondii	Olivaceous green at first, then whitish to ochraceous. Often confluent. Form variable.	Epiphyllous, densely gregarious. Covered, clear brown. Ostiole wide. Size 75 – 150 μ	Anicular, straight or slightly bent, few indistinct septa. 35 – 50 μ x 1·5 – 2 μ.
Ceylon species.	Olivaceous at first, then brown to white. Usually round, may be confluent. Purple border may occur. Yellowing of foliage conspicuous.	Epiphyllous and fewer hypophyllous. Covered, dull brown, (pale brown under microscope). Ostiole wide. Size 55 – 160 μ. Mean (50); 103 μ.	Filiform, rarely acicular. Straight or slightly bent. Continuous to 3–septate. 17 – 66·5 μ x 1·5 —3 μ Mean (50) : 43 μ x 2 μ

It will be seen from the above Table that the Ceylon form differs from any of the three published species in its epi-and hypophyllous pycnidia and in the far wider range of variation in size both of its pycnidia and spores. On the whole, it agrees more closely with *S. Drummondii* Ell. & Ev. than with any other species, and in view of its occurrence on the same host, this name is provisionally adopted for it. However, the wide variability of the Ceylon fungus, taken together with the fact that *S. Drummondii* as originally published was in any case more or less intermediate between *S. Phlogis* and *S. divaricatae*,

suggests that the distinctions between these three species are, in fact, hypothetical, and that a useful purpose would be served by combining them. Should this course be adopted, it would appear that *S. Phlogis* Sacc. & Speg., with an emended diagnosis, would be the most satisfactory name for the combined species. Support for the proposal can be inferred from the account in Grove's (7) book, while Pape (10) also, by including *Phlox Drummondii* in the list of species susceptible to leaf-spot caused by *S. Phlogis*, appears to have something of the same sort in mind. Experimental studies will, of course, be needed before the position can be fully cleared up.

Control measures for the disease have not been attempted, but judging from the recommendations of Clinton (2), Fikry (5) and other workers, satisfactory results should be obtained by strict attention to hygiene—destruction of infected leaves and plant remains—and, if considered necessary, fortnightly dusting with sulphur or spraying with Bordeaux mixture up till about blooming time.

The origin of the disease in Ceylon is not known ; it does not seem to have been reported from India (1), (9) although it is known to occur in other tropical countries (5), (8). It is worth nothing that the Phlox family, *Polemoniaceae*, among which alternate host plants might reasonably be sought, is not represented in the Ceylon flora. The plants affected were raised from freshly-imported seed, and the possibility of seed dispersal must therefore be considered. No observational data have been obtained to preclude this possibility.

SUMMARY

An account is given of a leaf spot disease of *Phlox Drummondii* associated with a species of *Septoria* new to Ceylon. The nomenclature of the fungus is briefly considered, with reference to the available descriptions of three *Septoria* spp. known to infect *Phlox*. The name *S. Drummondii* Ell. & Ev. is provisionally adopted.

ACKNOWLEDGEMENT

I am indebted to Mr. C. A. Loos for the accompanying photograph, Fig. I.

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RECENTLY INTRODUCED FOOD CROPS AT THE EXPERIMENT STATION, PERADENIYA
I—SORGHUM

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IN an agricultural country like Ceylon where rice constitutes the staple article of diet for which she has to depend to a great extent upon outside sources of supply, it is desirable in the interest of national economy that an attempt be made to find out suitable alternative sources of food which are capable of successful local production. These foods should be able to satisfy the dietetic requirements of the people by providing them with a well-balanced diet and should be easy to produce under the local conditions particularly in the dry zone areas where paddy cannot be produced satisfactorily in both seasons of the year without irrigation facilities and without artificial means to maintain the fertility of the soil. These alternative foods are not intended to replace rice which will, no doubt, continue to remain the staple article of diet ; but their main utility would be to furnish an appropriate variety in the food of the people so as to help in the formation of a better-balanced diet and in general to serve as desirable types of supplementary foods. The by-products of these crops should also be able to furnish fairly nutritive food for cattle.

In the south-west monsoon season of the year 1938 a number of food crops well known for their place in the daily diet of the people in Gujarat, Western India, Punjab, and in other parts of India were introduced on this station for preliminary trial.

The crops dealt with now are sorghum, pennisetum millet, and cowpeas. These crops have by now been under cultivation successively for four seasons at this station.

(1) **SORGHUM** (*Andropogon Sorghum*)

This is a very important cereal crop furnishing grain and fodder which has been grown for thousands of years and on millions of acres practically all over India except in very wet parts such as Bengal, Konkan, &c. Its adaptability to adverse conditions including its capacity to withstand drought and its suitability to a wide range of soils coupled with its ability to produce large quantities of fodder give it a paramount place in Indian agriculture. To the Indian cultivator this crop is more useful than either wheat or paddy because the fodder of sorghum constitutes a staple food for his draft animals. In the case of paddy the weight of straw produced is almost equal to or little more than the weight of grain, whereas in the case of sorghum it is two and a half to three times as much as the grain.

In food value, sorghum is superior to rice though inferior to wheat. In some parts of India, sorghum is regarded by people to be more wholesome than wheat or rice on account of its being more easily digestible. In many parts of India it is the staple cereal of the middle class as well as of the agricultural class. Sorghum seed on analysis is found to contain 10·42 per cent. protein, 1·93 per cent. fat and 1·76 per cent. mineral matter which clearly shows that sorghum is definitely better than rice as a food and superior to kurakkan in respect of protein and fat.

During recent years sorghum has witnessed great industrial developments in Madras Presidency. It is found capable of being substituted for barley in malting operations. One hundred pounds of sorghum grain yield 80 to 85 lb. of dry malt of which 60 to 65 per cent. is extractable with water. Every portion of the malt is found to be of use in one form or other. For domestic purposes, the process of malting sorghum has been so simplified that any person of average intelligence can prepare his own requirements of malt from sorghum and thus have fresh malted foods for the feeding of infants and invalids and for use even by healthy persons at very little expense. The home-prepared malted foods have been found to possess all the qualities attributed to the imported malted foods available in the market under various trade names. Ceylon uses these patented foods extensively and therefore there is a possibility of developing a small lucrative side industry from sorghum if the crop finds a place in the village agriculture of this country.

VARIETIES

There are a large number of varieties of this crop. It is due to this fact that it is found growing under a wide range of conditions. In Ceylon, sorghum is cultivated to a small extent

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Buddh Perio VARIETY OF SORGHUM.

in the Jaffna Peninsula under the name of *Cholam*. The varieties grown in Jaffna appear on examination to be essentially the fodder varieties as they generally have thin long stems, plenty of leaves and earheads small and loosely formed with very small-sized grain. These fodder varieties are quite distinct from the grain varieties and yield a very poor crop of grain. The problem was, therefore, to introduce a distinct grain variety. Surat and Broach Districts in Gujarat, Western India, are famous for the good quality of grain sorghum. Two varieties, *viz.*, *Buddh Perio* from Surat and Broach Selection No. 8 from Broach were therefore obtained for trial. Both the varieties have large-sized bright grain and the *Buddh Perio* variety is particularly noted for the compact character of its earheads as implied by its name. Broach No. 8 being a winter variety did not grow successfully during the first two seasons. It was, therefore, discarded during the south west monsoon season of 1939. The *Buddh Perio* variety appeared to be promising from the beginning and was, therefore, tried over a period of three seasons at the Experiment Station, Peradeniya. From the observations made of the standing crop at various stages of its growing period, the crop appeared to have excellent and luxuriant growth. However, in respect of the size of the earhead, it has been observed that the earheads obtained locally are somewhat smaller than those growing in the Surat District. This may be due to the fact that the Peradeniya conditions proved too wet for this crop, and as a result the size of the earhead was adversely affected on account of somewhat distinct vegetative growth of the crop. It is possible to overcome this handicap when this crop is cultivated in the dry zone. Another difficulty is that the grain gets discoloured under Peradeniya conditions on account of rain at a time when the crop is almost ready for harvesting. This difficulty is also capable of adjustment to some extent if the sowing time is so regulated that the harvesting may take place in a dry period. Locally-produced grain in respect of size and other points of quality is practically as good as the grain produced in the Surat District. The earheads have also maintained their character of being compact.

SOIL REQUIREMENTS

Sorghum can be grown on a wide range of soils from the lighter type of loamy soils to the heavy type of clay soils. Heavy soils should have drainage facilities as this crop cannot tolerate water-logging in any form. On light soils the growth is comparatively small and the crop matures fairly quickly. On fertile and retentive soils the growth is excellent and the crop takes a comparatively long period to mature. The spacing provided on such soils is wider than that on the lighter soils.

It is a fairly heavy feeder and therefore the soil should be naturally fertile or should receive about 5 tons of organic manure during the course of the preparatory cultivation.

CLIMATIC REQUIREMENTS

Sorghum requires a fairly warm and dry climate and, therefore, it can grow practically all over the dry zone areas. The amount and distribution of rainfall act as a limiting factor in the cultivation of this crop. It can be successfully cultivated in places where the rainfall in a season ranges from 25 to 40 inches. Places receiving higher than 40 inches rain are not suitable for this crop. There should be dry weather during the harvesting period as otherwise the grains are liable to be discoloured by moulds.

METHODS OF CULTIVATION

In India it is cultivated as an entire crop particularly when grown in the dry winter season. In the south-west monsoon season, it is cultivated either as an entire crop or as a mixed crop. In Ceylon it may be grown as an entire crop, or as a mixed crop with soybean, cowpeas, green gram or black gram.

The land can be prepared for sowing in the usual manner by ploughing and harrowing. The suitable spacing for the *Buddh Perio* variety under our local conditions will be 18″ apart between the rows and 12″ apart between plants in a row. The crop can, therefore, be drilled by a three-coultered drill in lines 18″ apart and then the plants can be thinned in the rows to a space of 12″. If the drill is not available, the crop can be dibbled to a spacing of 18″ by 12″ by depositing 3 to 4 seeds in each hole. The seed rate for this spacing usually ranges from 8 to 10 lb. per acre when grown as an entire crop.

As sorghum is liable to an attack of grain smut, it is desirable to treat the seed before sowing either by steeping it for 10 minutes in a 2 per cent. solution of copper sulphate or preferably by mixing with very fine sulphur powder at 1 oz. sulphur per 15 lb. seed as a preventive measure against smut disease. The sulphur treatment has been found to be very effective in the Bombay Presidency and its cost is almost negligible. So far this disease has not appeared either on this station, or in other parts of the Island where this variety has since been grown.

It was observed as a result of an experiment carried out by the Bombay Agricultural Department (*Department of Agriculture, Bombay, Leaflet* No. 18 of 1927) that large, plump, heavy, selected seed when used for sowing contribute an increase in yield to the extent of 50 per cent. It is, therefore, a distinct advantage to use only such selected seed wherever possible.

The germination is complete within about 10 days of sowing. Filling of vacancies and thinning out wherever necessary should be undertaken soon after the germination is over. Inter-cultivation depends on the character of the soil and rainfall. As soon as the crop is about 6 to 9 inches high, the first inter-cultivation should commence. In India this inter-cultivation is usually done by working two blade-hoes yoked to a pair of bullocks, and two acres are inter-cultivated in a day in this way. Two inter-cultivations and one hand weeding may prove sufficient for this crop.

Birds do a great deal of damage to this crop and, therefore, the crop requires to be watched against birds. Scaring of birds should commence soon after the earheads begin to fill up with grain. This has usually to be continued over a period of 5 to 6 weeks. This crop was observed to require a growing period of about 5 months under Peradeniya conditions.

The crop can be harvested either by cutting the whole plant close to the ground or by simply cutting the mature earheads first and then removing the stems. Under Ceylon conditions the crop is liable to be damaged any time by untimely rain and, therefore, it is always desirable to remove the mature earheads as and when they appear fit to be removed. As the crop does not mature evenly, the harvesting of the earheads will have to be carried out at frequent intervals till all the earheads are removed. The stems may then be removed by cutting close to the ground and used as fodder either in the fresh form or after drying as hay. If the stems are allowed to stand unduly for a long period in the field after the earheads have been removed, their value as fodder deteriorates. The earheads should be dried in the sun, and when they are fully dry they can be threshed for the separation of grain.

This crop is generally threshed under the feet of bullocks in the Indian villages. Recently a stone roller with a rough surface has been introduced and it performs the work of threshing very efficiently and economically. The cost of this stone roller is about Rs. 30 and with it the threshing work can be accomplished very quickly and cheaply.

YIELDS

In India the yield of grain on ordinary soils ranges from 700 lb. to 1,000 lb. per acre. On fairly good land and with reasonably good cultivation, the yield ranges from 1,000 lb. to 1,400 lb. per acre. The crop is known to respond to good cultivation and manuring. The crop grown at the Experiment Station, Peradeniya, on ordinary light soil on an area of $\frac{3}{4}$ acre in the south-west monsoon season of 1939 yielded $15\frac{1}{2}$ bushels or 930 lb. grain. The yield per acre therefore amounted to

1,240 lb. grain, a bushel of grain weighing 60 lb. at Peradeniya. This is quite a satisfactory yield in view of the adverse climatic factors that the crop had to encounter during this particular season. In the south-west monsoon season (*Yala*) of 1940 the excellent yield of 41 bushels or 2,460 lb. was obtained. This particular crop received 50 cart loads of compost per acre and one cwt. of Nicifos No. 2 as a top dressing six weeks after sowing.

METHODS OF USING AS FOOD

The grain is chiefly used in the form of flour. Thicker types of *Chapathi* or *Roti* can be made from the flour of this grain. In fact, sorghum flour can be used in almost all the ways in which kurakkan or maize flour is used, and in some of the ways in which wheat flour is used. In India, the grain is also used as popped corn after parching or roasting on a popper.

VARIETY AND CULTURAL EXPERIMENTS WITH COWPEAS

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IN connection with a co-operative, Empire-wide study of cultivated races of cowpea (*Vigna unguiculata* (L.) Walp.), initiated by Mr. H. C. Sampson, Economic Botanist, Royal Botanic Gardens, Kew, the performance of 93 varieties of cowpea collected from various parts of Ceylon was investigated at Peradeniya during the period 1933–40. An account even in outline of the vast volume of information accumulated is not attempted here. This contribution briefly reports the more important yield and cultural trials carried out at Peradeniya in the course of the investigation.

THE 1937-8 EXPERIMENTS

In the yala season, 1937, 43 varieties were selected for trial at Peradeniya. The seven best yielders in this season were tested out in maha 1937–8, in a randomized block layout comprising seven replications of 1/218 acre plots. Summary descriptions of these seven varieties are given in Table 1. Two seeds were dibbled per hill, and the seedlings subsequently thinned to a final stand of one per hill. The hills were spaced 2 ft. apart between and within rows. The area received no manure. Blanks were supplied. The plants were earthed up against *Agromyza phaseoli Coq.* and sprayed with a contact insecticide against aphids. None of the varieties were staked. Variety 3bb brown flowered and yielded earliest. Variety 18aa buff produced the most luxuriant vegetative growth. All the varieties were harvested as dry beans In harvesting a single border row was discarded round each plot.

The results of this trial are presented in Table 2. The analysis of variance of these data is given in Table 3. The variance ratio for varieties attains significance at the one per cent. point. The examination of individual treatment means reveals the significant superiority of 18aa buff to 3bb brown,

26 and 10a brown. The variety 18aa buff is, however, not significantly superior to 2a or 6. The differences between 2a, 6, 4, 3bb brown, 26 and 10a brown are not significant.

THE MAHA 1938-9 EXPERIMENT

The experiment set down in *maha* 1938–9 was similar in design to that of the previous *maha*, and included the same seven varieties. The number of replications was, however, reduced to four and the plot size increased to 1/134 acre. Cultural and harvesting methods resembled those adopted in the previous *maha*. Aphids were much more damaging than in the previous season. The prevailing dry weather also contributed to the numerous vacancies that occurred. No. 3bb. brown proved again to be the earliest of the varieties under test. Records of the numbers of dry pods and the weights of dry seeds harvested are given in Table 4.

In the analysis of variance of pod numbers (Table 5), the variance ratio for varieties exceeds the five per cent. point. The varieties 18aa buff, 6 and 2a are significantly more prolific than V4, 10a brown and 26. There are no significant differences between 6, 18aa, buff, 2a and 3bb brown, or between 3bb brown, V4, 10a, brown and 26.

In the analysis of variance of weights of dry seeds harvested (Table 6), the variance of ratio is just significant at the 5 per cent. point. The varieties 18aa buff and 6 yield significantly more than 26. The yield of 6 is also significantly greater than that of 10a brown. The differences between the other varieties are not significant.

THE MAHA 1939-40 EXPERIMENT

The results obtained in previous seasons suggested the restriction of further tests to the varieties 18aa buff, 6 and 2a. Seed of 2a was, however, not available in sufficient quantity. Furthermore, it was desired that the Botanist's selection V4 should continue to function as the control against which the performance of the others should be tested. The varieties 18aa buff, 6 and V4 were accordingly included in the *maha* 1939–40 tests. The layout consisted of six randomized blocks of 1/82-acre plots. The planting details and cultural and harvesting methods were the same as those in previous seasons. An early infestation of *Agromyza phaseoli* Coq. was effectively checked by earthing the plants up. Aphids, however, continued to be troublesome in spite of frequent spraying with contact insecticides. V4 exhibited a higher degree of resistance to aphid attack than the other two varieties. Apart from aphid damage, there were numerous casualties consequent on the prevailing dry weather.

The yields of dry seeds and the numbers of surviving plants in plots of the various varieties are recorded in Table 7. In the analysis of variance of yields uncorrected for plant number, the variance ratio for varieties did not reach significance even at the 5 per cent. point. In view of the lack of significance of the regression coefficient, it was, however, considered unprofitable to effect a correction for stand.

THE YALA 1940–41 EXPERIMENT

In yala, 1940–41, an investigation of the effect of staking cowpeas was superimposed on a trial of the three varieties tested in the previous *maha* season. The treatments were :

Varieties : 18aa buff
V4
6.

Staking treatments : A. Staked
B. Unstaked

The design of the experiment was factorial. The six treatments were replicated five times. Each plot contained three rows of 48 plants spaced 2 by 2 ft., and was approximately 1/76 acre. The plots were not separated by guard rows. A border row one plant deep was, however, planted round each block and was excluded from the harvest. Each plot was bisected transversely into two half plots each of which contained three rows of 24 plants. In every instance one half plot was harvested as green pods and the other half as dry beans. Three seeds were dibbled per hill on May 31, 1940, and the resulting seedlings subsequently thinned to one per hill. Vacancies were supplied. *Agromyza phaseoli* Coq. appeared in epiphytotic proportions but was effectively checked by earthing the seedlings up. Staking of the plants was begun seven weeks after sowing. It proved to be rather difficult to train V4 on to stakes ; the plants kept slipping off.

With the onset of dry weather the plants were heavily in fested with aphids and received two spraying with nicotine sulphate ($\frac{1}{2}$ oz. per gall.). Minor nuisances included the pod-boring caterpillar (*Maruca testulalis* Geyer) and leaf rust (*Uromyces appendiculatus* (Pers.) Link), both of which appeared at about harvest time.

V4 and 18aa buff flowered eight weeks after sowing. The variety 6 was markedly late. The first pick of green pods was taken on August 10. Very few plants of the variety 6 were ready for picking on this date. The numbers of plants picked on August 17, in the three varieties are given in Table 8. The distribution of these data is binomial. With non-normal data of this type, the inverse-sine transformation ($\theta = \sin \sqrt{p}$) should precede a valid analysis of variance. The analysis of the transformed data is given in Table 9. The variance ratio

for varieties is significant at the 0·1 per cent. point. The varieties 18aa buff and V4 are significantly earlier than 6 but do not differ significantly in age from one another. The practice of staking does not significantly affect the age of a variety.

The numbers and weights of pods picked green are recorded in Table 10. The analysis of variance of weights of pods is given in Table 11. The variance ratios for varieties and stakings are both significant at the 0·1 per cent. point.

The interaction of variety with staking is barely significant. The weight of green pods produced by 18aa buff is significantly greater than that produced by either of the other two varieties. V4 and 6 do not differ significantly in yield from one another.

The analysis of variance of numbers of pods picked green yielded variance ratios for varieties and stakings significant at the 0·1 per cent. point. The variety 18aa buff was markedly and significantly more prolific than the other two varieties. The difference between V4 and 6 is not significant.

The numbers of pods and weights of seeds harvested dry are given in Table 12. The analysis of variance of weights of dry beans is given in Table 13. The variance ratios for varieties and stakings exceed the 0·1 per cent. level of significance. The interaction between varieties and stakings is not significant. The variety 18aa buff is a significantly heavier yielder than the other two varieties. V4 and 6 do not differ significantly from one another. The analysis of variance of numbers of dry pods harvested gave comparable results.

The stimulus to pod production provided by frequent picking is strikingly illustrated in the present experiment. The numbers of pods harvested green and dry are presented in Table 14. The value of " t " for the comparison between the two treatments lies between the five per cent. and one per cent. points and accordingly indicates significance.

Records of the incidence of aphids made on September 16, were interrupted by heavy rains. Satisfactory data were, however, available for three of the blocks and are given in Table 15.

These data suggest that aphid infestation is accentuated by staking. The value of " t " for comparison of staked and unstaked plots is significant at the one per cent. point.

DISCUSSION

The earlier yield trials narrowed the choice of varieties down to 18aa buff, V4 and 6. All these varieties are of the cowpea type (Sampson, 1936) and possess 8–12 inch pods which become pendent early and are not inflated or flabby when green. There

is little to choose between them in matters of flavour and habit of growth. The later experiments aimed at securing accurate estimates of yields of the three varieties.

The consistently satisfactory performance of the variety 18aa buffis a feature of the experiments reported in this contribution. In none of the trials did V4 or 6 prove to be significantly superior to 18aa buff, and in the last season the production of both green pods and dry beans in 18aa buff was overwhelmingly greater than in the other two varieties. Other virtues claimed for 18aa buff include a significantly greater degree of resistance to *Agromyza phaseoli* Coq. than either V4 or 6 and a significantly shorter age than 6.

The investigation of the effect of staking undertaken in the yala season, 1940–41 is of considerable interest. The chief benefit derived from staking appears to be the more efficient arrangement of the photosynthetic surface of the plant in relation to the incident light. Other benefits claimed for the practice include the removal of the fruits and leaves from contact with soil-inhabiting pathogens and greater ease of picking. In Ceylon cowpeas are staked only if they belong to the asparagus bean type (*V. sinensis* var. *sesquipedalis* of Morse), or if they are grown on paddy field bunds ; asparagus bean types produce malformed pods if allowed to trail on the ground. The varieties 18aa buff, V4 and 6 are normally not regarded in this country as types that demand staking. In the instance of all these three varieties, however, staking produced large increases in the yield of both green pods and dry beans. The benefit of staking was particularly felt in 18aa buff and 6. No accurate estimates of costs are possible in an experiment of this type. It is, however, felt that in the instance of 18aa buff and 6 at least, the expenditure and labour involved in staking are justified by the significant and considerable increases in yield.

An incidental objection to staking cowpeas is the appreciably higher incidence of aphids on staked plants. Staking creates round plants conditions of low humidity which probably stimulate aphid development.

SUMMARY

This paper reports the results of variety and cultural experiments with cowpeas carried out at Peradeniya during the period 1937-41.

The performance of the variety 18aa buff was consistently satisfactory in all the experimental seasons. In yala 1940–41 18aa buff was markedly superior to the other varieties in the yield of both green pods and dry beans. Other desirable features of 18aa buff include earliness and resistance to *Agromyza phaseoli* Coq.

Staking of even varieties that are not normally trained on to stakes, resulted in large and significant increases in yield.

The incidence of aphids was higher on staked plants than on plants allowed to trail on the ground.

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[For Table 1 see page 159.]

TABLE 2.

Yields of dry seeds in ounces—Maha 1937–8

Blocks	Varieties							Totals
	18aa buff	V4	6	3bb brown	2a	10a brown	26	
I.	10·00	5·50	10·75	6·50	6·25	7·00	5·50	51·50
II.	5·25	3·75	3·00	10·25	3·25	3·00	4·00	32·50
III.	17·00	12·25	13·75	4·25	6·25	6·75	4·50	64·75
IV.	24·00	13·00	9·00	7·25	18·00	3·00	4·75	79·00
V.	6·00	1·00	1·50	4·50	4·75	2·25	2·00	22·00
VI.	1·50	1·75	4·00	0·75	5·25	1·25	1·50	16·00
VII.	14·00	4·00	0·25	5·00	4·25	0·75	2·75	31·00
Totals	77·75	41·25	42·25	38·50	48·00	24·00	25·00	296·75

TABLE 3.

Analysis of variance of weights of dry seeds

	DF	SS	MS	VR	1 per cent. point	0·1 per cent. point
Blocks	6	466·1403				
Varieties	6	276·9796	46·16326	3·69	3·47	4·73
Error	36	450·1633	12·50454			
Total	48	1193·2832				

Summary of Results

Yield	18aa buff	V4	6	3bb brown	2a	10a brown	26	Significant Difference
Oz.per/218acre	77·75	41·25	42·25	38·50	48·00	24·00	25·00	36
Lb. per acre	151·3	80·3	82·2	74·9	93·4	46·7	48·7	70·1

TABLE 1

Description of cowpea varieties

Variety	18aa buff	V4	6	3bb brown	10a brown	26	2a
Vernacular name	Digali-me	Polon-me	Sangu-vellai paithangai	Keerian	Polon-me	Polon-me	Vellaithoyan
Type	Cowpea	Cowpea	Cowpea	Cowpea	Cowpea	Cowpea	Cowpea
Habit	Procumbent	Low, half-bushy	prostrate	prostrate	prostrate	prostrate	prostrate
Leaves	persistent	persistent	shed	persistent	persistent	persistent	persistent
Colour of stem	green with some purple pigment	green	green with some purple pigment	green	green	green with some purple pigment	green with some purple pigment
Colour of leaf stalk	do.	do.	do.	do.	green with some purple pigment	do.	do.
Colour of leaf	do.	do.	green	green with some purple pigment	green	do.	do.
Colour of young pod	green	light green with purplish streaks	light green	light green with purplish streaks	light green with purplish streaks	purple tip and dorsal	purple tip
Colour of mature pod	brown	straw with purple blotches	pale straw	straw with purple patches	straw with purple blotches	straw	straw
Colour of flower	violet	violet	violet	violet	violet	violet	pale violet
Pod habit	horizontal	horizontal	horizontal	horizontal	horizontal	pendent	horizontal
Pod characters :							
length	7·1 in.	7·7 in.	7·7 in.	7·3 in.	9·1 in.	7·4 in.	—
Depth/breadth	0·8	0·56	0·73	0·8	0·61	0·62	—
Inflated or fully filled	inflated	fully filled	fully filled	inflated	—	fully filled	fully filled
straight, curved or coiled	curved	—	curved	curved	curved	curved	curved
Average No. of seeds per pod	13	15	15	15	16	15·5	
Seed closely or loosely packed	closely packed	closely packed	closely packed	closely packed	closely packed	closely packed	closely packed
Shape and length seeds	subreniform 8·1±0·06 mm.	subreniform 8·5±0·06 mm.	subreniform 8·4±0·04 mm.	subreniform 7·80±0·12 mm.	reniform 9·7±0·07 mm.	rhomboid 7·1±0·05 mm.	reniform 9·7±0·10 mm.
Colour of seeds	burnt sienna	black with occasional maroon or brown spots	burnt sienna	marbled brown on black	maroon on black and brown on black	black	burnt sienna
Locality	Koslanda	Peradeniya	Jaffna	Jaffna	Batapola	Peradeniya	Jaffna

TABLE 4

Numbers of dry pods and weights of dry seeds—Maha, 1938–39

BLOCKS		VARIETIES 18aa buff	V4	6	3bb brown	2a	10a brown	26	TOTAL
I.	No. of dry pods	537	387	668	520	743	159	485	3499
	Wt. of dry seeds	29 oz.	24 oz.	31 oz.	20 oz.	27 oz.	10 oz.	18 oz.	159 oz.
II.	No. of dry pods	963	381	842	473	725	481	434	4299
	Wt. of dry seeds	48 oz.	24 oz.	39 oz.	19 oz.	28 oz.	33 oz.	17 oz.	208 oz.
III.	No. of dry pods	1152	492	937	664	1024	423	607	5299
	Wt. of dry seeds	52 oz.	30 oz.	46 oz.	29 oz.	50 oz.	31 oz.	30 oz.	268 oz.
IV.	No. of dry pods	492	564	988	827	469	510	201	4051
	Wt. of dry seeds	26 oz.	33 oz.	44 oz.	42 oz.	16 oz.	31 oz.	9 oz.	201 oz.
Total	No. of dry pods	3144	1824	3435	2484	2961	1573	1527	17148
	Wt. of dry seeds	155 oz.	111 oz.	160 oz.	110 oz.	121 oz.	105 oz.	74 oz.	836 oz.

TABLE 5

Analysis of variance of numbers of dry pods

	DF	SS	MS	VR	5 per cent. point	1 per cent. point
Blocks	3	242990	80997			
Varieties	6	686768	114461	3·76	2·66	4·01
Error	18	548181	30454·5			
Total	27	1640639				

Summary of results

Yield	18aa buff	V4	6	3bb brown	2a	10a brown	26	Significant Difference
No. of pods per 4/134 acre	3144	1824	3435	2484	2961	1573	1727	1037
No. of pods per acre	105324	61104	115073	83214	99194	52696	57855	34739·5

TABLE 6

Analysis of variance of weights of dry seeds

	DF	SS	MS	VR	5 per cent. point	1 per cent. point
Blocks	3	836·72	287·91			
Varieties	6	1336·43	222·74	2·85	2·66	4·01
Error	18	1405·28	78·07			
Total	27	3578·43				

Summary of results

Yield	18aa buff	V4	6	3bb brown	2a	10a brown	26	Significant Difference
Oz. per 4/134 acre	155	111	160	110	121	105	74	53
Lb. per acre	324·5	232·4	335·0	230·3	253·3	219·8	154·9	110·1

TABLE 7

Yields of dry beans and numbers of surviving plants—Maha, 1939–40

VARIETY		BLOCKS I.	II.	III.	IV.	V.	VI.	
18aa buff	Wt. of dry beans	49·0 oz.	18·5 oz.	17·5 oz.	11·0 oz.	13·0 oz.	4·0 oz.	113·0 oz.
	No. of surviving plants	109	110	107	105	92	60	583
V4	Wt. of dry beans	23·5 oz.	9·5 oz.	22·0 oz.	16·5 oz.	8·5 oz.	32·0 oz.	112·0 oz.
	No. of surviving plants	110	110	110	109	105	108	652
6	Wt. of dry beans	30·5 oz.	24·0 oz.	13·0 oz.	19·0 oz.	20·0 oz.	10·0 oz.	116·5 oz.
	No. of surviving plants	110	104	98	82	102	100	596
Total	Wt. of dry beans	103·0 oz.	52·0 oz.	52·5 oz.	46·5 oz.	41·5 oz.	46·0 oz.	341·5 oz.
	No. of surviving plants	329	324	315	296	299	268	1831

TABLE 8

Percentages of Plants harvested on August 17, 1940.

Blocks	18aa buff		V4		6	
	Staked	Unstaked	Staked	Unstaked	Staked	Unstaked
I.	77·8	77·8	84·1	97·1	35·5	24·2
II.	66·2	44·4	47·0	47·2	13·8	13·3
III.	88·9	100	57·4	59·7	32·8	20·7
IV.	75·3	59·4	69·9	61·4	23·5	10·9
V.	87·3	77·5	75·7	72·9	42·6	37·3

TABLE 9

Analysis of variance of transformed data ($\theta = \sin^{-1}\sqrt{p}$)

	DF	SS	MS	VR	0·1 per cent. point
Blocks	4	1517·05	379·26		
Total treatments	5	6014·43	1202·89	15·58	6·46
Varieties	2	5917·01	2958·51	38·34	9·95
Stakings	1	30·80	30·80		
Interaction	2	66·62	33·31		
Error	20	1543·29	77·16		
Total	29	9074·77			

TABLE 10

Numbers and weights of green pods

Blocks		18aa buff		V4		6		Totals
		Staked	Unstaked	Staked	Unstaked	Staked	Unstaked	
I.	No.	3779	1788	1716	1388	2606	1020	12297
	Wt.	38·8 lb.	18·8 lb.	28·3 lb.	22·5 lb.	25·4 lb.	10·8 lb.	144·6 lb.
II.	No.	2481	1592	732	849	1468	912	8034
	Wt.	24·5 lb.	14·8 lb.	9·4 lb.	11·9 lb.	13·3 lb.	7·6 lb.	81·5 lb.
III.	No.	3056	2154	1220	845	2088	1874	11237
	Wt.	30·8 lb.	20·9 lb.	18·1 lb.	12·7 lb.	18·6 lb.	17·3 lb.	118·4 lb.
IV.	No.	3064	2173	1253	845	1673	1078	10086
	Wt.	31·8 lb.	21·5 lb.	19·6 lb.	13·3 lb.	17·9 lb.	10·8 lb.	114·9 lb.
V.	No.	3660	1526	1676	1229	2593	638	11322
	Wt.	36·9 lb.	15·2 lb.	28·8 lb.	19·1 lb.	25·1 lb.	6·6 lb.	131·7
Total	No.	16040	9233	6597	5156	10428	5522	52976
	Wt.	162·8 lb.	91·2 lb.	104·2 lb.	79·5 lb.	100·3 lb.	53·1 lb.	591·1 lb.

TABLE 11

Analysis of variance of weights of green pods

	DF	SS	MS	VR	5 per cent. point	1 per cent. point	0·1 per cent. point
Blocks	4	372·84					
Total treatments	5	1329·13	265·8	16·89	—	—	6·46
Stakings	1	686·40	686·40	43·61	—	—	14·82
Varieties	2	532·69	266·35	16·92	—	—	9·95
Interaction	2	110·04	55·02	3·50	3·49	5·85	—
Error	20	314·78	15·74				
Total	29	2016·75					

Yield	18 aa buff	V4	6	Significant Difference
Lb. per 10/76 acre	254·0	183·7	153·4	37·0
Lb. per acre	1930·4	1396·1	1165·8	281·2

TABLE 12

Numbers of dry pods and weights of dry seeds

Blocks		18aa buff		V4		6		
		Staked	Unstaked	Staked	Unstaked	Staked	Unstaked	
I.	No. of pods	1474	1475	535	576	737	633	5430
	Wt. of seeds	4·47 lb.	4·30 lb.	2·28 lb.	2·44 lb.	2·28 lb.	1·37 lb.	17·14 lb.
II.	No. of pods	2172	1538	733	776	1052	728	6999
	Wt. of seeds	6·92 lb.	4·44 lb.	3·37 lb.	3·06 lb.	3·30 lb.	2·37 lb.	23·46 lb.
III.	No. of pods	1653	1602	289	377	678	465	5064
	Wt. of seeds	5·37 lb.	4·53 lb.	1·28 lb.	1·73 lb.	2·06 lb.	1·54 lb.	16·51 lb.
IV.	No. of pods	2356	1552	840	518	992	743	7001
	Wt. of seeds	7·06 lb.	4·48 lb.	3·44 lb.	2·20 lb.	3·16 lb.	3·06 lb.	23·40 lb.
V.	No. of pods	2880	1427	1184	460	1310	358	7619
	Wt. of seeds	9·89 lb.	3·97 lb.	6·20 lb.	3·22 lb.	6·44 lb.	0·97 lb.	30·69 lb.
Total	No. of pods	10535	7594	3581	2707	4769	2927	32113
	Wt. of seeds	33·71 lb.	21·72 lb.	16·57 lb.	12·65 lb.	17·24 lb.	9·31 lb.	111·20 lb.

TABLE 13

Analysis of variance of weights of dry seeds

	DF	SS	MS	VR	5 per cent. point	1 per cent. point	0·1 per cent. point
Blocks	4	22·1799					
Total treatments	5	73·1394	14·6279	11·54	—	—	6·46
Varieties	2	50·9383	25·4691	20·08	—	—	9·95
Stakings	1	18·9449	18·9449	14·94	—	8·10	14·82
Interaction	2	3·2562	1·6281	1·28	3·49	—	—
Error	20	25·3620	1·2681				
Total	29	120·6813					

Yield	18aa buff	V4	6	Significant Difference
Lb. per 10/76 acre	55·43	29·22	26·55	10·50
Lb. per acre	421·3	222·1	201·8	79·8

TABLE 14

Numbers of pods harvested green and dry

Block	No. of pods Harvested		Difference (green—dry)
	green	dry	
I.	12297	5430	+6867
II.	8034	6999	+1035
III.	11237	5064	+6173
IV.	10086	7001	+3085
V.	11322	7619	+3703
	52976	32113	+20863

$t = 3·9$

(For $n = 4$: $P = 0·05$, $t = 2·776$
$P = 0·01$, $t = 4·604$)

TABLE 15

Number of plants infested with aphids in staked and unstaked plots

Block	Variety	Number of infested plants.		
		Staked	Unstaked	Difference.
I.	18aa buff.	4	0	+ 4
	V4	4	0	+ 4
	6	11	0	+11
II.	18aa buff	10	0	+10
	V4	18	1	+17
	6	14	3	+11
III.	18aa buff	35	0	+35
	V4	3	0	+ 3
	6	8	1	+ 7
		107	5	+102

$t = 3 \cdot 4$

(For $n = 8$ and $P = 0 \cdot 01$, $t = 3 \cdot 355$)

DEPARTMENTAL NOTE

THE VEGETATIVE REPRODUCTION OF KAPOK

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THE object of this note is to issue a warning to anyone who may contemplate the propagation of kapok by budding. The actual technique is simple—90 per cent. success has been obtained with patch budding—but care must be taken to choose the buds from the right part of the mother tree. Information has been available for some time that buds taken from the main stem would produce an upright tree, but that, if the buds were taken from a side branch, the growth would tend to be drooping ; no evidence was available, however, and as the point is one of considerable practical importance, buddings have been made with buds taken from the two sources mentioned, and observations made on the subsequent growth of the scions. The observations may be summarized in the following table : —

Source of buds.	Number of successful grafts.	Resultant growth.	
		Upright.	Lateral.
Main stem ..	69	69	—
Side branches	60	13	47

The figures confirm the information already available, and indicate the necessity of using only buds from the main stem if an upright tree is to result.

The accompanying photographs illustrate the types of growth to be expected from the two types of buds. Plate I. shows two budded plants, from which it is seen that the two types of growth are distinguishable soon after the buds have shot. In *all* cases where buds from side branches were used, the scion emerged from the stock at a greater angle than where buds had been taken from the main stem ; in some cases, however, the growth subsequently became upright, and produced the plants that are classified as " upright " in the table above. Plate II. shows a good example of the lateral type of growth, after one year from budding. The future growth of this tree will be watched with interest, but it would obviously be undesirable to have a plantation of trees of this type.

It is immaterial from what part of the main stem buds are taken or from what tier of side branches ; the only distinction is between the main stem and its branches.

Block by Survey Dept.

FIG. 1.—KAPOK BUD TAKEN FROM MAIN STEM.

Block by Survey Dept.

FIG. 2.—KAPOK BUD TAKEN FROM SIDE BRANCH.

PLATE II.

Block by Survey Dept.

A KAPOK PLANT BUDDED WITH A BUD FROM A SIDE BRANCH,
AFTER ONE YEAR'S GROWTH.

SELECTED ARTICLES

CITRUS GROWING IN WESTERN AUSTRALIA*

(Continued from the last Number.)

MANURING OF CITRUS.

CITRUS trees when once established will go on producing fruit for years without any special manurial treatment, but eventually they become unthrifty or fail completely. It will then take several years at least of heavy manuring to restore them to a good healthy condition again, so it is far better to keep the trees going steadily by the regular application of suitable manures. It is generally recognized that all fruit trees need an all-round manure containing phosphates, nitrogen and potash, but the proportion of each of these elements and the amount used is largely dependent on the age and condition of the tree and the natural richness of the soil. Most of our soils are deficient in one or more of these necessary constituents but in the absence of experimental data it is impossible to recommend any mixture or fixed quantity of fertilizer for all soils. The whole problem is a question of balance between the necessary plant food elements, and while analysts may determine the chemical constituents of a tree and its crop we cannot guarantee that by placing these constituents in the soil the plants will receive them, for chemical changes take place in the soil and may render some of the substances insoluble or at least unavailable to the plant.

A fertilizer mixture that has given good results and maintained trees in growth and cropping is a mixture of superphosphate, sulphate of ammonia and sulphate of potash roughly in the proportion of 2.2.1. and giving an analysis of P_2O_5 9 per cent., N 8 per cent. and K_2O 10 per cent. Some growers prefer to use bone-dust or blood and bone, but these are not balanced and should be fortified with soluble phosphate and potash.

If good crops of leguminous plants have been regularly ploughed in for a number of years the proportion of nitrogen in the mixture can safely be reduced; otherwise the trees tend to become too rank and produce a soft and insipid fruit, which does not keep well.

The quantity of fertilizer to apply is largely dependent on the size of the trees but dressings of over 10 cwt. per acre should seldom be necessary, and an average of 4 to 6 lb. per tree is often adequate. When purchasing manures it is far better to spend, say, £10 on a ton of well-balanced manure than the same amount on two or more tons of manure containing, say, only phosphates, unless

* By R. C. Owen, Horticultural Adviser, in the *Journal of Agriculture*, Western Australia, December, 1940.

there is definite evidence to show that only phosphates are required. In other States it is often advocated that sulphate of ammonia or nitrate of soda should be applied at the annual rate of one pound per tree for every year of the tree's age up to twelve years. That is, a tree of more than twelve years of age would receive twelve pounds of concentrated nitrogenous manure every year. In this State where we experience long dry summers and heavy rains during the ripening and maturity period of our orange crops, that amount of nitrogen would be out of all proportion.

Lemon trees which produce heavy crops of fruit and which must be kept growing strongly, will stand heavier nitrogenous manures than oranges and other fruits.

The time for applying manures to citrus is still controversial but as the trees are evergreen and growth is intermittent throughout the year there is some evidence that to divide the annual amount into two or three dressings, say, early Autumn, Spring and Summer is beneficial.

This summer dressing can only be applied where irrigation is possible, for it would be unwise to apply readily soluble manures when the trees are stressed for want of water.

The phosphate and potash manures, because they do not readily wash out of the soil, may be safely applied in one dressing and placed as deeply as possible in the soil. If, however, the soil is rich in iron, there is a danger of the soluble phosphate becoming changed to insoluble iron phosphate and thus lost to the plant. In that case the phosphate could be applied as acid soluble basic phosphate which though only slowly available to the plant would last in the soil for a long time. Readily soluble nitrogenous manures may be applied as a top dressing during the Spring or Autumn or with the irrigation waters in the Summer.

IRRIGATION

As mentioned previously, citrus trees need an ample supply of water, especially through the hot summer, and as 80 per cent. of our normal rainfall occurs between the months of May to October the remaining six months of hot dry weather put a severe test on water reserves in the soil. There are very few orchards here which can adequately maintain full bearing citrus trees throughout the year without irrigation, but unfortunately there are many places which through lack of sufficient water supply are denied this necessary irrigation and consequently the trees never have a chance to produce their quota of good quality fruit.

It is surprising just how much drought an orange tree will endure and still mature fruit of a sort, but that fruit is usually small, of poor texture and juice content and affected by drought crinkle. Another effect of drought is out-of-season fruit caused by the trees flowering profusely after the flush of sap caused by Autumn rains.

At present there are no big acreages of citrus in our recognized irrigation areas and practically all the orchard irrigation is carried out from comparatively small private schemes. A few fortunate growers situated on permanent water-courses in the hills can gravitate the water on to their orchards with very

little cost, but the majority have to instal plants commensurate with the size of their orchards, or in accordance with their available water supply. These supplies are drawn from the local rivers, creeks, soaks and wells and there are various systems of applying the water to the soil.

Where the supply is limited and the orchard is not graded the most economical method for even distribution is through pipes and sprinklers. This method is more costly in power and the initial installation of piping and also neccessitates some form of cultivation after each watering, but there is actually less work involved, and there is no soil washing. This method is becoming increasingly popular with citrus orchardists. Some growers use movable sprinklers connected by hoses to the fixed supply pipe, others make use of light piping made from galvanized sheet metal with the sprinklers fixed directly into the pipes. These pipes can be easily shifted about and coupled up again so that when one land has been watered the pipes are set up in another place, and so on until the whole orchard has been covered. Usually the sprinklers are left running for 1½ to 2 hours in the one place and this approximates 1½ to 2 inches of water.

Where the water supply is adequate and the land is better graded the method of open furrow irrigation can be used. The water is caused to flow down one or more open furrows between the trees the number of furrows depending on the flow of water and the type of soil concerned. Furrow irrigation is more difficult to control unless the grade is even and the subsoil uniform in texture. There is always a tendency for some trees to be overwatered, while others might not receive sufficient ; if drainage is not sufficient seepage may occur and cause water-logging and consequent damage to the trees.

For the best results use comparatively short furrow leads—not more than five chains—and use the maximum volume of water without causing scouring. The practice of watering citrus by flooding, where the butts of the trees are inundated or kept wet for any length of time should be strongly condemned, for it will eventually lead to loss or damage to the trees through collar-rot and brown rot gummosis.

Whatever system of water reticulation is used it is preferable to give a few good waterings at long intervals rather than frequent waterings of short duration. Do not commence irrigation before it is necessary because heavy applications early in the season are likely to chill the ground and may check the activity of the roots and the soil bacteria.

Within a day or two after irrigation the soil should be lightly cultivated to loosen up the surface and prevent any weeds from growing.

PRUNING

Pruning of citrus is not classed as essential by many growers and while it is true that young trees need very little in the way of pruning excepting to keep the main framework open the older trees are in most cases benefited by some form of pruning to remove the dead and dying fruit wood.

Valencias which have a more free and open type of growth need only occasional cutting to keep the branches off the ground and to remove spent fruiting woods. Navels, however, rapidly become dense and unthrifty if pruning

is neglected for long especially as the trees advance in years. The nature of a Navel tree is to expand by throwing out successive layers of fruiting wood and as the older wood outlives its usefulness it slowly dies and is succeeded by new growth. As this new growth extends it gradually shuts out the light and the fruiting wood inside the tree is forced out of existence. The dead wood in itself is harmful because it scratches and blemishes the fruit and also forms a breeding ground for harmful fungous diseases, but the worn out wood is just as harmful because without helping in the necessary metabolism of the plant it is still living and in effect is robbing other parts of essential plant food. This worn out wood should be removed by pruning as soon as it becomes weakly and in doing so the dead wood of the future will be dispensed with.

The outer surface of the tree should be kept sufficiently open to allow light and air to circulate but not too open to allow the direct rays of the sun to penetrate and scald the main branches. The inside fruiting wood may also be thinned to allow the remainder plenty of room to bloom and crop. If the work is done regularly the tree can be kept strong and healthy and that tendency for over-blooming followed by poor setting—usually a sign of a weakened condition—can be overcome.

Mandarin trees, too, become very dense and bushy if not pruned. This leads to the tree becoming weakly and bearing large crops of small fruits poor in quality.

The important thing is to anticipate that too-heavy crop and reduce it by judiciously thinning out the fruiting wood. This will maintain a better balance between the fruit and wood growth and so keeps the tree in a healthy and profitable state.

Lemon trees respond readily to good pruning but if neglected they soon deteriorate. To fully realize this it is only necessary to crawl under one—this in itself is a feat requiring skill and determination—and take a look from the inside. There will be seen a dense mass of dead and dying wood interlaced by watershoots and suckers struggling to reach the light. Finally if they ever reach the outside they blossom and carry a bunch of fruit which sways about and becomes hopelessly blemished before it is even half grown.

The lower branches, too, when tangled on the ground interfere with the harvesting and cultivation ; in the winter they keep the trunk and main limbs so damp that the health of the tree is endangered.

The lemon tree can be kept fairly open, and by regular pruning the fruiting wood should be renewed as soon as it shows signs of flagging.

Even young and vigorous trees can be benefited by using secateurs. Those long rank shoots should be shortened back to stimulate the growth of finer lateral fruiting wood which carries the better quality fruit. By carefully observing the time and effect of this style of pruning from one season to another it is possible to stimulate the production of the summer crop of fruit. In most districts it takes ten to twelve months from the time of pruning to force the new laterals, carry the blossom and mature the fruit, so that if the pruning is done in the early summer months the resulting crop should be ready for harvesting

during the summer of the following year. In an endeavour to stimulate the summer crop the grower must be prepared to sacrifice a portion of the winter crop which will have already set. Control of soil moisture by irrigation is essential to bring a heavy summer crop of lemons to size and maturity.

It is better to prune lightly every year or two rather than to wait till the tree is a mass of unthrifty wood before cutting it heavily in an endeavour to restore its vigour and fruitfulness.

HARVESTING

Harvesting the crop is quite as important and needs just as much care and attention as any of the other cultural items. Some growers who are most particular in giving the trees every attention to produce excellent fruit, spoil the effect and actually lose money by careless methods of picking and packing. Oranges, and in fact all citrus fruits, have their juicy pulp protected by a more or less tough skin and can be kept for a considerable time after they are normally ripe provided that skin is not damaged. Once the surface is broken the spores of decay organisms gain access and the fruit rapidly breaks down.

When fresh picked the cells of the skin and rind are full of moisture and are easily bruised or scratched, so great care should be exercised during picking operations. Actually the fruit should not be picked but cut from the trees with a pair of blunt-nosed snips. During the work the operator should wear soft gloves or at least keep his finger nails closely trimmed to avoid damage to the fruit. Picking bags which are strapped to the shoulders are most convenient receptacles for holding the fruit before it is transferred to the boxes, because they leave both hands free for work. Gently grasp the fruit with the left hand and with the snips in the right hand cut the stem an inch or so back from the fruit, then with a second cut neatly sever the short piece of stem close to the button. By making the two separate cuts the stem which would otherwise die back is removed from the tree, also the cut close to the fruit can be made closer and cleaner with less risk of damage. Fruit should be placed—not dropped—into the picking bag. Do not over-fill the bag as this tends to crush the skin, especially if the picker is working from a ladder. Carefully transfer from the bag to the packing boxes. So far as possible avoid picking the fruit when wet; if this is not practicable then as soon as convenient afterwards spread the fruit out on a bench in the shed to dry. Fruit intended for long transport or for storage is better if not packed immediately, but left for some days in a cool, dry place so that the excess moisture in the skin can dry out. This causes a toughening of the rind and makes the skin less susceptible to injury.

Oranges in commercial quantities do not keep for long periods in store, and it is usual to let them remain on the trees till convenient to market. In districts where the fruit matures early the grower should avail himself of the higher prices ruling to dispose of his crop—within the limits of the market—before the later districts commence harvesting. In this way the loss through windfalls will be appreciably less and the mid-season gluts can in some measure be avoided. The grower in the late maturing districts, however, is faced with a different problem. Most of his Navel crop is ripe during the months of plentiful supplies and he has the choice of marketing the bulk of the crop at

comparatively low prices or risking heavy losses by windfalls and breakdowns in an endeavour to keep some of the fruit for the higher prices ruling towards the close of the season. The decision rests with the grower, but if he chooses to keep his Navel oranges on the tree for months after they mature, then it is only natural to expect a proportion of windfalls and decayed fruit.

LEMON HARVESTING AND CURING

Oranges and mandarins and to a lesser extent grapefruit are marketed within a comparatively short time of picking, but lemons, apart from winter fruits for factory purposes, are better if cured before being sent to market. In this case the fruit should be picked before it is fully coloured or ripe. Pick to size rather than to colour for the market requires a moderately small lemon of about 2¼ inches in diameter, and if allowed to fully develop some of the fruit would be oversize and coarse in texture. Green fruit may be picked when it attains 2½ inch diameter, for in the process of curing it will shrink considerably. Most of the crop will be picked just as it is turning in colour from green to yellow, and this is the ideal stage for curing. As with other fruit careful picking and handling is essential, the main cause of fruit rotting and becoming mouldy in the curing room can be traced to bruises and scratches received in picking.

Grade the lemons before curing and cull out all mis-shapen, blemished or tree-ripe fruits, for they will not warrant curing, and only occupy valuable space in the chamber. If the market warrants it these culls can be packed fresh or disposed of to the factory for processing either for peel, juice or essential oil.

The curing process is really only a slow reduction in the moisture content of the skin accompanied by a change in colour and in the general texture of the whole fruit. During the process the skins become tougher, but more fine and thin and assume a soft leathery feel, the rag or white pithy substance practically disappears. There will be some loss in size through shrinkage and this varies according to the type and stage of maturity of the original fruit. There is very little, if any, loss in the actual juice content and the proportion of juice to the total weight of fruit is greatly increased.

The secret of successful lemon curing is to carefully pick the fruit before it is too mature and then place it in a room or container where the moisture reduction can be controlled. If the moisture is lost too rapidly, or too much is lost, the fruit will become shrivelled and will look unattractive : if the rate of curing is too slow there will be a bigger chance of losing a proportion through mould and breakdown.

The curing room must not be draughty and should be kept at a moderately even temperature. Once it was considered that an underground room or cellar was essential for lemon curing, and although very suitable it has no advantage over an ordinary room where the temperature can be kept regulated and the ventilation controlled.

Some growers placed the lemons in clean sand or sawdust and either of these gives very good results, but both entail extra handling and cleaning. A method which is very much simpler and which also gives excellent results, is to place

the fruit loosely in boxes, stack them in the curing room and cover entirely with a light tarpaulin or sacking. A little experience will indicate just the amount of covering necessary and inspections can readily be made to see when the fruit is cured. The usual time for complete curing is from three to six weeks, varying according to the temperature and the state of maturity of the fruit. Once cured the fruit can be marketed immediately, or if the price does not warrant sale, can be kept in the room for weeks or even months without serious deterioration. Lemons picked during the drier months of the year can be cured with very little trouble, but during the cold damp months of mid-winter when the skins are soft and full of moisture it is practically impossible to get consistently good results. Probably artificial heating and air conditioning would solve the problem.

USE OF ETHYLENE GAS

Citrus fruits showing green colour, if kept for a few days in an atmosphere charged with ethylene gas will rapidly change colour and take on the appearance of normal ripe fruit. This treatment does nothing more than colour the rind and leaves the pulp and juice content unchanged. It is valuable for re-colouring ripe Valencias which have reverted to a green colour through being left on the trees, and is also used for prematurely colouring lemons and Navel oranges. Lemons, of course, are normally sold for their juice, which is rich in citric acid, and as this acid is present even in immature fruit, the gas-treated fruit does not differ much from the normal lemon.

Oranges, however, are expected to contain a certain proportion of sugars and to be reasonably sweet to the taste, but immature oranges which have been artificially coloured by gas treatment are often lacking in this respect. The purchaser relying on colour as a sign of sweetness, is often deceived into buying fruit which is not true to nature's label.

There are arguments for and against this gas treatment for colouring immature oranges, but so long as the public are willing to pay higher prices for well-coloured oranges early in the season, the enterprising grower will do his best to supply that need. Growers, however, would do well to remember that the consumer once deceived may not be inclined to buy again till late in the season. This temporary loss of public buying would have serious repercussions on the market price.

PACKING

By far the greater part of Western Australia's citrus crops are consumed within the State, and the small export trade is practically confined to Java, Singapore and Colombo. For local trade the fruit is usually packed in the Australian dump case, the three-quarter dump case, or the three-quarter bushel flat case. For export the standard citrus case holds 1 1/3 bushels but half citrus box holding 2/3 bushel may be used for lemons.

Before packing the fruit should be graded for size and quality, and firmly packed in the cases, using only those packs which will bring the top layer of fruit level with the top of the case without undue squeezing. The number of fruit in the case should be legibly marked on the outside so that the prospective buyer can see it at a glance and mentally work out the cost of the fruit per dozen.

DISEASE AND PESTS

As with growing other kinds of fruit or in producing any other type of agricultural commodity there are a number of pests and diseases to contend with in citrus growing. Every year these diseases take their toll and a proportion of the crop is lost entirely or is reduced in value. Practically all pests and diseases have their particular remedy and the careful grower who takes due precautions to combat these pests may find some consolation in the fact that if plant diseases were unknown the production figures would rapidly increase to such an extent that unless new markets were found the monetary returns would be very low indeed.

It is not possible in this article to give details of the diseases which affect citrus trees and fruit but most of these diseases and their control are dealt with in various bulletins and " Journal " articles of this department. These can be had free of charge on application.

BUDDING AND GRAFTING

It has been mentioned earlier in this article that in this State there are still many citrus trees of the older seedling types and varieties of low commercial value. These trees in many instances do not pay for their upkeep and should be dealt with accordingly. Where the tree is unhealthy or unthrifty through disease of the roots and trunk it is a waste of time to do anything else than grub it out and if desirous, replant with a healthy tree of suitable variety. If the tree is still healthy and vigorous it may be worked over to a more profitable variety, and will in a few years time produce good crops of fruit for which there will be a market demand. Apart from the semi-dwarf varieties of mandarin trees which may not form good stocks for more vigorous kinds, all commercial citrus varieties can be successfully grafted or budded one on the other. Citrus wood, because it does not callous readily, is not the easiest to graft, but provided the work is done carefully in the early spring—August and September—there should be fair prospects of success. Large trees must be cut back for reworking and if cleft grafted scions are inserted in the cut limbs there is a chance that they will grow. If these scions fail, the cut limbs will send out numerous new shoots which will be fit to bud the following season. When cutting back a tree for reworking always leave a few limbs intact to provide shade for the trunk and main arms. A coat of limewash painted or sprayed on any exposed limbs will do much to protect the bark from sun scald. One of the greatest difficulties in budding or grafting citrus is to procure suitable scions and budding wood. It is desirable to select scions from mature trees which have proved themselves heavy and regular bearers of good quality fruit, but these trees very often only produce fine fruiting wood unsuitable for grafting or budding. When a grower anticipates reworking a number of old trees it is a good idea to prune back a portion at least of the desired bud-wood tree so that it will make strong enough growth to provide scions in time for the contemplated budding or grafting operation.

Budding into vigorous young shoots which arise after the old tree has been headed back, is the most reliable method of reworking citrus. Use the ordinary shield method of cutting the bud and insert in the stock by making a " T " or

inverted " T " cut. The bud should be cut from one year old round wood of one quarter to one half inch in diameter. Younger wood is usually too angular to provide suitable buds. Cut the bud to include a thin piece of wood which keeps the shield piece of bark more rigid and facilitates its insertion under the bark of the stock. If this piece of wood is removed it may injure the bud itself and often prevents good results. Buds put in during the spring may be forced into active growth by removing the upper portion of the stock immediately the bud has healed in, but buds put in during late summer and autumn are better left dormant till the following spring. If the top growth is then cut back the young bud will have the whole growing season to establish itself.

Young growths from buds and grafts should be suitably protected against injury from strong winds.

SUMMARY

In conclusion it must be realized that in these days of keen competition and fluctuating markets the citrus grower in common with other primary producers must keep the cost of production at a minimum. This can only be accomplished by growing good commercial varieties on suitable soils in districts where natural conditions are not altogether uncongenial. Plant only those varieties suited to the district, and by scientific cultural methods endeavour to keep all the trees in a healthy and vigorous condition. Use care in picking and handling and by marketing only fruit consistently true to name and grade, build up a reputation for reliability.

Without unlimited capital you cannot keep an orchard. Make the orchard keep you.

ZINC CONTENT OF SOME TROPICAL FOODS*

A MAJOR problem of modern nutrition science concerns the distribution and physiological role of those mineral elements which occur in small amounts in animal and plant tissues. Study of the literature shows that in addition to the better known mineral elements occasions have arisen, when traces of aluminium, cobalt, copper, nickel, fluorine, zinc and zirconium among others have appeared essential if the proper utilization of the diet is to be secured. Occasionally it seems that some of these elements have been associated with pathological conditions, but further investigation has tended to show that under varied dietary environment it is sometimes possible to substitute one of these elements for another. This probably means that insufficient investigation has as yet been carried out. Again the literature indicates the nutritional value of some of these " trace " elements without being able to apply any well-defined label to the condition brought about by the difficiency or absence of such elements.

The study of zinc in relation to food illustrates these points. A comprehensive review was published by Rose (1929) and need not be recapitulated here. Since that date McCollum (1933) has published the results of some experiments which led him to the conclusion that while there was no evidence that zinc was essential to growth it appeared to be essential for normal reproduction. The negative results of McCollum as far as growth is concerned were not altogether confirmed by Elvejhem and Hart and their colleagues. In 1934 they reported that a low content of zinc in the diet, not only retarded the growth of rats but also interfered with the normal development of the fur. In 1937 they reported that a deficiency could be arrested by the presence of 40 gammas of zinc per day. Metabolism experiments upon rats receiving only 22 gammas of zinc showed a marked decrease in the growth rate and this appeared to be due to a lowered efficiency in the utilization of food. They found that the nitrogenous metabolism including endogenous metabolism was lowered. Their experiments offered no indication that the carbohydrate metabolism was affected. In this connection, however, it may be mentioned that zinc in combination with insulin is sometimes employed as zinc-protamin-insulin on account of its modified hypoglycemic action. Elvejhem and Hart (1938) conclude their studies with the suggestion that zinc, like several other trace elements, will probably be found to possess a specific role in the activation of some enzyme. In this connection it is of interest to observe that the distribution of zinc in local foods follows to a considerable extent that of vitamin B_1.

There is yet but little indication of the human requirement. It has been estimated that a man of 70 kilograms contains 2·2 grams of zinc in his composition. This is almost as much as the amount of iron estimated by Sherman 2·8

* By J. P. Morris, from the Biochemical Laboratory, King Edward VII. College of Medicine, Singapore.

grams. Scoular (1939) however, reports the results of 35 balance experiments on children of pre-school age. She concluded that 0·307 milligrams per kilogram of body weight would supply the need for zinc, and that if excessive amounts are taken, they are not absorbed but excreted through the alimentary tract.

This small amount scarcely bears relationship to the amount contained in the body, but from the earlier experiments of Hubbell and Mendel (1927) and those of McCollum mentioned above it would appear that lower amounts may be needed for growth than for reproduction. The main physiological function of children should be growth.

A typical daily diet for two adults and three children in Singapore can be stated as consisting of $2\frac{1}{4}$ katties rice, 2 katties fresh fish, 330 grams Chinese mustard leaf (sayor sawi) and 200 grams of pork. This yields just over 6 milligrams of zinc per adult per day. Since the average weight of a Singapore adult asiatic is 58 kilograms the amount of zinc in such a diet is equivalent to 0·1 milligram per kilogram of body weight instead of 0·307 milligram as recommended by Scoular.

Thus while it is not yet possible to state the specific role of zinc, it seems clear that it must be considered as one of the essential nutritional catalysts.

In order to be able to understand more fully the importance of the mineral elements the composition of the numerous experimental diets which are being studied in this laboratory have to be analysed as completely as possible. Some of these elements have already been studied by Morris and Rosedale (1935); the distribution of zinc in local foods is now presented, and other elements are already being studied.

The experimental procedure adopted for this work has followed that of Eggleton (1938) using 1·5. Diphenylthiocarbazone (Dithizone) in chloroform.

The author wishes to express his thanks to Professor J. L. Rosedale for his helpful criticisms, suggestions and encouragement during this investigation.—

ZINC CONTENT OF FOODS EXPRESSED IN MILLIGRAMS PER 100 GRAMS OF EDIBLE PORTION.

Animal Products.

Abalone	2·13	Cuttle fish, dried	1·02
Beef	2·17	Salt fish, dried	0·38
Blachan	2·63	Ikan Tinggeri	0·29
Cheese, Red Cheddar	0·91	Ikan Merah	0·33
Crab flesh	1·41	Tunny	0·46
Edible Bird's Nest	0·067	Shark's Fins	1·37
Egg Hen's Whole	0·87	Oysters (Australian)	6·68
Egg Yolk	3·68	Oysters (Rock)	10·38
Egg White	0·021	Oysters (Muar River)	9·87
Egg Duck's	0·76	Milk fresh (Cold Storage)	0·41
Egg Duck's Salted	1·311	Milk (Malayan Farm)	0·38
Chicken flesh	1·48	Milk Sterilized	0·36
Mutton	2·92	Milk Condensed, Sweet	0·81
Pork	2·44	Lactogen	2·55
Cuttle fish, fresh	0·71	Milk, Dried Skim	1·24

Cereals and Pulses.

Atta (Wheat flour)	1·07	Ragi (Millet)	1·48
Barley	2·28	Rice Polished	1·02
Bread, Brown	0·43	Rice Husked	1·88
Bread, White	0·38	Rice Polishings	1·91
Dhall, Green	1·09	Sago	0·18
Dhall, Red	2·14	Soya Bean, Black	2·50
Dhall, Yellow	3·33	Soya Bean, White	5·20
Butter Beans	3·12	Soya Bean Cake	0·54
Haricot Beans	4·28	Soya Bean Curd	0·56
Black Gram	1·11	Tapioca	0·04
Macaroni (Egg Noodles)	1·69	Wheat	2·46
Mee Sua	1·19	Quaker Oats	2·35
Maize	1·42	Peanuts	1·91

Fruits.

Apple	0·031	Jack Fruit	1·23
Banana	0·181	Jack Fruit Seeds	0·83
Bua Lye	0·011	Mango	0·055
Bua Chicku	0·009	Orange	0·61
Chempedak	0·056	Papaya	0·41
Chempedak Seeds	0·036	Pumelo	0·32
Coconut	5·03	Pineapple	0·025
Guava	2·41	Tomato	0·301

Vegetables.

Bamboo Shoots	1·05	Lobak	0·174
Beet root	0·61	Lettuce (inner leaves)	0·45
Bitter Gourd	0·793	Lettuce (outer leaves)	0·33
Bottle Gourd	0·683	Patola (Lufius)	1·43
Cabbage (inner leaves)	0·58	Potato	0·32
Cabbage (outer leaves)	0·43	Pumpkin	0·075
Carrot	0·53	Sayor Puteh	0·63
Cucumber	0·063	Snake Gourd	0·091
Egg Plant	0·33	Spinach	0·65
French Beans	0·59	Spring Onions	0·43
Green Pepper	0·31	Sprouted Beans	0·50
Green Peas (in tin)	4·04	String Beans	0·22
Kang Kong	0·99	Sweet Potato	0·86
Lady's-fingers	0·51	Yams	1·14
Leeks	0·21		

Condiments and Curry Stuffs.

Chillies (dried)	0·16	Garlic	0·93
Chillies (green)	0·056	Pepper corns	0·23
Onions (small)	1·29		

Miscellaneous.

Cattle horn *Calculated on dry weight*	12·86
Human toe and finger nails *Calculated on dry weight*	10·83
Human hair pigmented	14·51

MEETINGS, CONFERENCES, &c.

COCONUT RESEARCH SCHEME

BOARD OF MANAGEMENT.

MINUTES OF THE FIFTY-FOURTH MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT BANDIRIPPUWA ESTATE, LUNUWILA, ON MONDAY, MARCH 31, 1941, AT 10.30 A.M.

PRESENT.

Mr. E. Rodrigo, Acting Director of Agriculture (Chairman) ; Mr. O. B. M. Cheyne ; Mr. A. R. Ekanayake ; Mr. A. F. R. Goonewardene ; Mr. D. D. Karunaratne, J.P. ; Mr. G. Panditteseker, J.P., U.M. ; Mr. H. W. Peiris ; Mr. E. R. Tambimuttu, M.S.C.

Dr. R. Child, Director of Research, acted as Secretary. Apology for absence was received from Mr. C. E. Jones, C.C.S.

MINUTES.

The minutes of the previous meeting held on Friday, December 6, 1940, were confirmed.

It was decided to modify the existing procedure by sending the minutes to the Press without waiting for members' approval of the circulated minutes.

BOARD OF MANAGEMENT.

The Chairman reported the following :—

(*a*) Mr. G. Panditteseker had been renominated by His Excellency the Governor as Smallholders' Representative for a further three years from January 1, 1941.

(*b*) Mr. S. Phillipson had been deputed by the Financial Secretary as an *ex-officio* member of the Board from December 7, 1940, in place of Mr. C. H. Collins.

On February 19, 1941, Mr. C. E. Jones had been deputed by the Financial Secretary to succeed Mr. Phillipson as a member of the Board.

(*c*) Dr. S. C. Paul succeeded Mr. James P. Fernando as Chairman of the Low-Country Products Association on March 24, 1941, and so became an *ex-officio* member of the Board.

STAFF.

(*a*) The Board approved of an application from the Director of Research for two months' leave in Ceylon.

(*b*) *Junior Staff Medical Scheme.*—Following the discussion at the previous meeting, the details asked for had been circulated. It was decided that it

was not possible to institute such a scheme at the present time owing to financial stringency, but that the Board approved of the Scheme in principle and would give the matter due consideration should it be possible to do so later.

(*c*) *Appointment of Mr. R. W. Senaratne* as Field Assistant to the Geneticist's Department from January 20, 1941, was confirmed.

ANNUAL REPORT.

The following reports were tabled :—

(*a*) *Annual Report of the Board of Management for 1940.*—The Chairman mentioned that this report had as usual been approved for publication as a Government Sessional Paper and was in the hands of the Government Printer.

(*b*) *Report of the Auditor-General for 1940.*—See para. Finance (*b*) below.

(*c*) *Report of the Director of Research on Bandirippuwa estate for 1940.*—In reply to a question by Mr. Ekanayake, the Director of Research said that separate yield records of all blocks and subdivisions were kept.

The Director of Research mentioned in reply to a question by Mr. Goonewardene that the experiments carried out on fly breeding in poonac by the Medical Entomologist of the Department of Medical and Sanitary Services in collaboration with the Scheme had been completed. Permission would be sought from the Director of Medical and Sanitary Services to make the results available to the Board.

FINANCE.

(*a*) *The Statement of Receipts and Expenditure* for the quarter ended December 31, 1940, was tabled.

(*b*) *Date of Annual Audit.*—The Auditor-General had called attention to para. 27 of his Report for 1939. It was decided to reply that the Board's opinion that section 8 (2) of Ordinance No. 29 of 1928 (Cap. 303), did not appear to imply that the audit of the Scheme's accounts should be completed by January 31 in each year, but only that the statement of receipts and payments for the previous year should be prepared by that date ; and further to suggest that the Auditor-General should get the opinion of the Legal Secretary on this point. Only should legal advice not be in agreement with the Board's opinion was any amendment of this section of the Ordinance called for.

ESTATES.

(*a*) *The Progress Reports* of Bandirippuwa and Ratmalagara Estates from July to December, 1940, were tabled.

(*b*) *Copra Kiln.*—The Chairman reported that the Patent Copra kiln, of which the Board had authorized the construction at the last meeting, had been completed.

The Director of Research undertook to keep all particulars of working costs and to report on them after the kiln had been in operation some months.

MISCELLANEOUS.

(*a*) *Small Holdings Officers.*—With reference to the discussion at the previous meeting, the Chairman said that as then decided the Chilaw Planters' Association

had been asked to supplement their resolution with suggestions regarding the work and usefulness of small holding officers. The Planters' Association had appointed a sub-committee for this purpose, whose report was awaited.

(*b*) *Research Apprentices.*—The Chairman referred to the discussion on this subject at the fifty-second meeting held on September 27, 1940. The Director of Research had discussed the question with the Professor of Chemistry, University College, Colombo, and put forward the following points :—

(i.) It might be difficult to get graduates to take up work as research students or apprentices without guarantee of permanent employment.

(ii.) A subsistence allowance of Rs. 100 was the least which could be regarded as reasonable.

(iii.) In England, where there were openings in industry, &c., such students were compelled to carry out their one year's or two years' period or refund their allowances received. In Ceylon this was not possible. For the first three months some such restriction might be imposed, but after that the student should be free to take up employment if it was offered.

(iv.) The Scheme's financial position was much less favourable than when the subject was previously considered and in fact did not really permit of an increase of expenditure of Rs. 2,400 per annum.

The Chairman said that the question should also be considered in relation to a motion moved at the previous meeting of the Central Board of Agriculture by Mr. A. A. Wickremasinghe :—

(i.) This Board is of opinion that adequate provision should be made to provide both advanced courses of study as well as practical training in estate management as a post-graduate course to qualified students.

(ii.) This Board is further of opinion that provision should be made for such students to reside at the various research centres, to wit :—Tea, Rubber and Coconut Research Schemes.

He thought that the Board should authorise the Director to state at the next meeting of the Board of Agriculture that the Board of Management was quite willing to make provision for two graduates to work as research students or apprentices, but that unfortunately their resources were insufficient for them to meet the expense. Further the Board did not consider that it was practicable to provide facilities for training in elementary science or for general agricultural training on Bandirippuwa Estate.

The Board was in general agreement with the view but Mr. Panditteseker was emphatic that at least one appointment should be made at once without waiting to see what recommendation to the Honourable Minister would be made by the Central Board of Agriculture. He thought that from the point of view of extending " consumption " research, which was Mr. Jas. P. Fernando's main object in raising the question in September, 1940, the question was urgent.

After further discussion, the Board decided to appoint a " Probationer Research Assistant " on a temporary basis, who should be an Honours Graduate

on a stipend of Rs. 100 per month without any other allowances whatever. No guarantee could be given of security of tenure other than one month's notice, but should any provision be made by Government or should the Scheme's own financial position improve, the terms of service would be revised accordingly. It was decided to advertise early so that this assistant could take up duties on Dr. Child's return from leave early in June, 1941.

(*c*) *Dispensary at Palu Bingiriya.*—Correspondence with the Chairman, Yagam Pattu Village Committee, was tabled. The Board agreed that they would be willing to lease, for the purpose of a dispensary, an area not exceeding $\frac{1}{2}$ acre of jungle of Ratmalagara Estate, at the site included on a sketch plan submitted. The rental would be nominal.

OTHER BUSINESS.

Replanting.—Mr. Goonewardene spoke on the subject of replanting old coconut lands and inquired what was being done to study the subject of underplanting. The Director of Research referred to the experiment on manuring underplanted young palms which is being carried out on a Nattandiya estate. Mr. Goonewardene thought it desirable to compare in the field the system of clearing out old trees before putting in new plants and the usual practice of underplanting. The Director of Research undertook to try and get facilities to carry out a trial on a suitable old estate.

The meeting adjourned at 12.30 P.M.

REVIEW.

The Diseases of the Coconut Palm.—By H. R. Briton-Jones, D.Sc., Ph.D. Revised by E. E. Cheesman, M.Sc., A.R.C.S., Pp. XVI. 176 ; 37 Plates. Available from Messrs. Bailliere, Tindall & Cox, 7 and 8, Henrietta Street, London, W. C. 2. Price 10*s*. 6*d*.

THE late Professor H. R. Briton-Jones was unfortunately unable to complete the final revision of the text of this book owing to his untimely death in November, 1936. Subsequent to his death, publication was, of necessity, somewhat delayed, and Professor E. E. Cheesman has made revisions and additions to the original text in view of later investigations. The book now published fills a long-felt want as literature on diseases of coconuts is not readily available to planters and, coming as it does from one who had such wide experience, it is very welcome. It is much to be regretted that Professor Briton-Jones did not live long enough to know how much his book will be appreciated.

Perhaps the most valuable contribution made by the author to our knowledge of coconut diseases has been the result of his studies of diseases which have been somewhat loosely termed " bud-rot ", " root disease " and " tapering disease ". In this book he has lucidly differentiated the diseases which have hitherto been grouped together under one or more of the above headings. His main work has been in the elucidation of the disease to which he has given the name " Bronze Leaf Wilt ", in the description of which Ceylon coconut planters will recognize the symptoms of what is commonly miscalled " root disease " or less commonly " tapering disease " in this country. He has shown that the disease is caused by conditions which prevent the palm from obtaining from the soil a regular supply of water, in other words, drought, which may be climatic or physiological. The chapter on Bronze Leaf Wilt is recommended for careful study by coconut planters. It is clearly written and written in language which is remarkably free from the technical jargon which makes so many scientific works unintelligible to the average layman.

The chapter on Phytophthora bud-rot is interesting in that " leaf-bitten disease ", which occurs rather uncommonly in Ceylon, is included, the author's view being that the disease is a form of Phytophthora bud-rot in which the apical cell is not actually destroyed.

Subsequent chapters deal with Tapering Stem Wilt or Pencil Point Diseases, Red Ring Disease (not recorded in Ceylon), Lightning Strike, Stem Bleeding Disease, Root Diseases, Leaf Disease and Gumming Disease and dropping of nuts.

The book is profusely illustrated, the plates being of a uniformly high standard and readily illustrating the points brought out in the text. The book is admirably printed and, although rather expensive, is strongly recommended to all coconut planters.—M.P.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED FEBRUARY 28, 1941

Province, &c.	Disease	No. of Cases up to date since Jan. 1, 1941	Fresh Cases	Deaths	Recoveries	Balance ill	No. shot
Western	Rabies	3	2	..	..	..	3
	Piroplasmosis	1	1	..	1	..	..
Colombo Municipality	Anthrax	..	..	..	..	..	..
	Rabies	11	4	11	..	..	..
Cattle Quarantine Station	Anthrax	4	4	4	..	..	..
Central	Rabies	24	12	6	..	..	18
	Bovine Tuberculosis	6	3	..	..	..	6
Southern	Foot-and-mouth disease	43	43	1	..	42	..
	Rabies	2	1	..	..	..	2
Northern	Foot-and-mouth disease	48	48	..	48	..	..
Eastern	Foot-and-mouth disease	23	..	3	20	..	..
	Rabies	3	1	..	..	..	3
North-Western	Anthrax	18	3	18	..	..	..
	Rabies	2	2	..	..	..	2
	Contagious Mange	8	..	..	7	..	..
North-Central	Haemorrhagic Septicaemia	30	30	30	..	..	..
Sabaragamuwa	Piroplasmosis	1	..	..	1	..	..
	Rabies	1	..	1	..	..	..

Department of Agriculture,
Peradeniya, March 21, 1941.

S. C. FERNANDO,
for Deputy Director (Animal Husbandry) and
Government Veterinary Surgeon.

METEOROLOGICAL REPORT, FEBRUARY, 1941

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta ..	91·2	+1·4	71·7	+0·5	74	98	4·4	7·27	11	—
Anuradhapura ..	86·8	0	71·3	+2·0	75	95	5·4	2·53	7	+ 1·04
Badulla ..	79·6	+0·6	64·7	+1·6	70	91	4·6	3·38	10	+ 0·89
Batticaloa ..	83·9	+1·1	75·3	+1·6	76	88	5·8	8·71	11	+ 6·03
Colombo ..	89·1	+2·3	73·5	+1·5	69	90	5·6	3·06	10	+ 0·86
Diyatalawa ..	75·3	+0·4	58·2	+1·7	66	88	5·9	2·04	9	+ 0·24
Galle ..	86·2	+1·0	74·6	+1·1	74	88	4·8	5·43	8	+ 2·44
Hakgala ..	71·7	+1·7	53·2	+2·8	70	85	5·7	2·68	9	— 0·74
Hambantota ..	87·4	+1·4	74·3	+1·4	72	88	5·6	0·77	3	— 0·27
Jaffna ..	86·0	+0·4	73·2	+1·0	69	90	5·0	1·63	3	+ 0·47
Kandy ..	87·5	+1·2	68·4	+1·4	66	85	5·5	1·44	4	— 0·36
Kurunegala ..	90·1	+0·2	71·2	+1·9	62	90	4·3	3·87	5	+ 2·18
Lunuwila ..	93·5	+4·1	73·2	+2·1	62	93	4·7	0·15	2	—
Mannar ..	85·8	+0·8	75·3	+1·7	69	84	6·2	1·19	4	— 0·54
Nuwara Eliya ..	70·7	+0·8	47·0	+2·7	62	93	7·2	1·77	7	+ 0·06
Puttalam ..	90·7	+2·4	71·3	+1·2	66	93	5·5	0·12	2	— 0·95
Ratnapura ..	92·4	+0·6	73·2	+2·0	61	90	5·5	4·65	9	+ 0·21
Talawakele ..	77·9	+1·8	55·6	+1·2	56	76	5·6	1·68	9	—
Trincomalee ..	83·3	+0·7	77·5	+1·8	72	80	5·9	7·33	6	+ 5·29

The rainfall for February was distributed rather irregularly on either side of average, but on the whole excesses covered the greater part of the Island. Being a month of generally little rainfall, deficits cannot attain large values. The largest deficits were 3·53 inches at Koslanda, 3·25 inches at Blackwood, and 3·16 inches at Udahena.

Excesses of over 10 inches occurred at a number of stations, either on the north-eastern slopes of the hills or in the east coastal districts. Appreciable excesses also occurred at a couple of stations in the south-west. Outstanding excesses were Alutnuwara 14·37 inches, St. Martin's Upper 14·28 inches, Sakamam Tank 13·69 inches and Hendon 13·40 inches.

Rainfall totals of over 20 inches for the month were registered at 3 stations, St. Martin's Upper 23·39 inches, Hendon 23·36 inches and St. Martin's Lower 20·84 inches. About a dozen stations received no rain at all during the month.

There were 13 daily falls of 5 inches and over reported, the largest being 7·40 inches at Sengapodai on the 6th, on which day the majority of these falls occurred.

North-easterly pressure gradients and winds prevailed throughout the month. Nearly the whole of the rains fell between the 4th and the 12th. Particularly dry periods were 16th-19th and 23rd-25th. An appreciable amount of thunderstorm activity was reported.

Temperatures were consistently above average. The highest shade temperature recorded was 98·6° at Lunuwila on the 25th, while the lowest temperature was 34·7° at Nuwara Eliya on the 18th. Humidity was generally above average by day and below average by night. Cloud amounts were on the whole in excess. Winds were above normal strength, the prevailing direction being north-easterly.

D. T. E. DASSANAYAKE,
Superintendent Observatory.